Vols:-

1 to 8 mal.

1947-76

3|nd.

TRANSACTIONS

OF THE

DEVONSHIRE ASSOCIATION

FOR

THE ADVANCEMENT OF SCIENCE, LITERATURE,
AND ART.

1862-1866.

VOL. I.

LONDON:
TAYLOR & FRANCIS, RED LION COURT, FLEET STREET.
PLYMOUTH: W. BRENDON, GEORGE STREET.

REPORT

OF

THE FIRST MEETING

OF THE

DEVONSHIRE ASSOCIATION

FOR

THE ADVANCEMENT OF SCIENCE, LITERATURE, AND ART,

HELD AT EXETER, AUGUST, 1862.

LONDON:
TAYLOR & FRANCIS, RED LION COURT, FLEET STREET.
PLYMOUTH: W. BRENDON, GEORGE STREET.

1863.

OFFICERS.

1862-63.

President:

SIR JOHN BOWRING, LL.D., F.R.S., F.L.S., &c. &c.

Vice-Presidents:

WM. KENDALL, Esq., *The Right Worshipful the Mayor of Exeter.*
SIR LAWRENCE PALK, Bart., M.P., *Haldon House.*
A. H. A. HAMILTON, Esq., *President of the Exeter Naturalists' Club.*
THOMAS SHAPTER, Esq., M.D., *Exeter.*

Treasurer:

WILLIAM VICARY, Esq.

Hon. Secretaries:

CHAS. SPENCE BATE, F.R.S., F.L.S., &c. &c.
REV. W. HARPLEY, M.A., &c.

Local Hon. Secretary for the Meeting at Exeter:

HENRY S. ELLIS, Esq., F.R.A.S.

Council:

R. T. ABRAHAM, Esq.
T. F. BARHAM, Esq., M.D.
REV. REGINALD BARNES, M.A.
HENRY S. ELLIS, Esq., F.R.A.S.
JONATHAN N. HEARDER, Esq.
W. F. MOORE, Esq., *President of the Plymouth Institution*
G. W. ORMEROD, Esq., M.A., F.G.S.
WM. PENGELLY, Esq., F.G.S.
REV. J. E. RISK, M.A.
W. R. SCOTT, PH.D., *President of the Devon and Exeter Graphic Society*
W. S. M. D'URBAN, Esq.
ED. VIVIAN, Esq.

LIST OF MEMBERS.

ABRAHAM, R. T., *Heavitree, near Exeter*
BALKWILL, ALFRED, *Plymouth*
BALKWILL, FRED., *Plymouth*
BARHAM, T. F., M.D., *Highweek, Newton Abbot*
BARNES, REV. R. H., M.A., *Marychurch, Torquay*
BASTARD, S. S., *Summerland Place, Exeter*
BATE, C. SPENCE, F.R.S., F.L.S, &c., *Hon. Sec., Plymouth*
BERRY, RICHARD, *Chagford*
BOWRING, SIR JOHN, LL.D., F.R.S., F.L.S., &c., *Claremount House, Exeter*
BRENT, R., M.D., *Woodbury*
BUCKNILL, J., M.D., *Exminster*
CANN, WM., *West of England Insurance Office, Exeter*
CHIGNELL, REV. T. W., *Queen Square, St. Leonard, Exeter*
COLLEY, J., *Plymouth*
CRESSWELL, C. H., *Heavitree*
DABB, JAS., *Plymouth*
DANSEY, GEO., M.D., *Stoke, Plymouth*
DIVETT, JOHN, *President of the Teign Naturalists' Field Club, Bovey Tracey*
D'URBAN, MAJOR GEN., *Newport, Exeter*
D'URBAN, W. S. M., *Newport, Exeter*
DYMOND, ROBT., Jun., *Friars, Exeter*
ELLIOT, W. H., M.D., *Bouverie House, St. Leonard, Exeter*
ELLIS, HENRY S., F.R.A.S., 1, *The Quadrant, St. Leonard, Exeter*
FOLLETT, JOHN, *Mount Weir, Exeter*
GAMLEN, W. H., *Tiverton*
GENDALL, JOHN, *The Close, Exeter*
GLANVILLE, STEPHEN, *Bouverie Place, St. Leonard, Exeter*
HAMILTON, A. H. A., *Millbrooke, near Exeter*
HARPLEY, REV. WM., M.A., M.C.P.S., *Plymouth*
HAYWARD, JOHN, *The Close, Exeter*
HEARDER, G. E., *Torquay*
HEARDER, JONATHAN N., *Plymouth*
HEDGELAND, R. W., M.A., *St. Leonard, Exeter*
HINE, JAS., C.E., *Plymouth*
HORNE, F. B., M.R.C.S., *Torquay*
INGLE, REV. JOHN, M.A., *Mount Radford House, near Exeter*
JONES, WINSLOW, *St. Loyes, Heavitree*
KENDALL, W., J.P., *Summerland Place, Exeter*
MARDON, REV. B., M.A., *Sidmouth*
MILES, W., *Dix's Field, Exeter*
MOORE, W. F., *President of the Plymouth Institution*
ORMEROD, G. W., M.A., F.G.S., *Chagford*
OXLAND, ROBT., F.C.S., *Plymouth*
PALK, SIR LAWRENCE, M.P., *Haldon House*
PARFITT, EDWARD, *Devon and Exeter Institution, Exeter*
PEACOCK, GEO., *Starcross*
PENGELLY, W., F.G.S., *Torquay*
POLLARD, W., Jun., M.R.C.S., *Torquay*
PYCROFT, G., *Kenton*
RIDGWAY, C., PH.D., *Marlborough House, Exeter*
RISK, REV. J. E., M.A., *Plymouth*
ROGERS, W., *Countess Weir, near Exeter*
ROOKER, ALFRED, *Plymouth*
ROPER, C. H., M.R.C.S., *Magdalen Street, Exeter*
ROWE, J. BROOKING, F.L.S., *Hon. Local Secretary, Plymouth*
SCOTT, W. R., PH.D., *St. Leonard, Exeter*
SEARLE, JAMES, *Crediton*
SERCOMBE, RUPERT, *Fairfield, Exeter*
SHAPTER, T., M.D., *Barnfield, Exeter*
SHEPPHEARD, A. B., *Torquay*
SHUTE, ROBT., *Baring Crescent, Exeter*
STEWART, R., M.R.C.S., *Torquay*
TEESDALE, C. L., *Swiss Cottage, Exeter*
TEMPLETON, JAS., M.A., F.G.S., *Exeter*
THOMAS, JAMES L., *Exeter*
TURNER, T., *Manston Terrace, Heavitree*
VICARY, W., Treasurer, 7, *Albert Terrace, St. Leonard, Exeter*
VIVIAN, E., *Torquay*
WIDGER, W., *Torquay*

BYE-LAWS

OF THE

DEVONSHIRE ASSOCIATION

FOR THE ADVANCEMENT OF

Science, Literature, & Art.

THE OBJECTS of the Association are—to give a stronger impulse, and a more systematic direction, to scientific enquiry, and to promote the intercourse of those who cultivate science, literature, and art, in different parts of Devonshire, with one another, and with others.

ADMISSION OF MEMBERS AND ASSOCIATES.

All persons present at the first meeting shall be entitled to become members of the Association upon subscribing an obligation to conform to its rules.

All other persons desirous of becoming members shall be nominated by a member.

All members shall pay the sum of 10*s.* annually, and have the privilege of a Lady's Ticket.

Associates for the Meetings shall pay the sum of 5*s.*, and Ladies 2*s.* 6*d.*

The Society shall have the power of electing Honorary Members, chosen from such eminent men as may be connected with the West of England; and Corresponding Members, from persons at a distance, who may feel an interest in this Society.

REPORTS.

The Society shall, every year, publish a Report, including a financial statement, and a list of the members.

All members shall be entitled to receive a copy.

MEETINGS.

The Society shall meet annually. The place of each meeting shall be appointed by the General Committee at the previous meeting; and the arrangements shall be entrusted to the Officers of the Association.

GENERAL COMMITTEE.

The General Committee shall sit during the time of the meeting, or longer, to transact the business of the Association.

It shall consist of Presidents and Officers of the present and preceding years, together with all members of the current year.

The General Committee shall have the power of authorising such sums of money, as may be convenient, from the funds of the Society, for the purpose of scientific investigation.

LOCAL COMMITTEES.

The General Committee shall annually appoint a Local Treasurer and Secretary, who shall form a Local Committee, with power to add to their number, to assist in making arrangements for the meetings.

OFFICERS.

A President, two or more Vice-Presidents, one or more Secretaries, and a Treasurer, shall be annually appointed by the General Committee.

The President shall not be eligible for immediate re-election.

COUNCIL.

In the intervals between the meetings, the affairs of the Association shall be managed by a Council, appointed by the General Committee. The Officers being ex-officio members.

ACCOUNTS.

The Accounts of the Association shall be Audited annually, by Auditors appointed by the Meeting.

FIRST ANNUAL REPORT.

THE Council of the Devon Association for the advancement of Science, Literature, and Art have much pleasure, in this their first Annual Report, in being able to congratulate the Members on the complete success of the year's proceedings.

In establishing a Society of the character of the Devon Association, many difficulties present themselves; amongst these, not the least is that of obtaining good and efficient officers, such as will not only carry out their respective duties satisfactorily, but will also, from their social position, their Literary standing, and their courtesy and urbanity of manner, give a character to the proceedings of the Society, which must materially influence its future success. In obtaining these happy combinations in the officers for the year, the Council believe they have been eminently successful.

Sir John Bowring, F.R.S. &c., a name long associated with the literature of Europe, kindly consented to become the President, and The Right Worshipful the Mayor of Exeter, not only welcomed the Association to the city in his official capacity, but also kindly allowed his name to be placed amongst the Vice-Presidents.

It will be seen from the list, that the other offices were equally satisfactorily filled.

It was thought by those interested in the formation of the Society, that the first meeting might appropriately be held in Exeter, as the chief city of the county, and the 14th of August was appointed as the day for the Association to com-

mence its sittings. On this day, the Members assembled at the Clarence Hotel, and after the appointment of officers, &c., the President delivered his address. This address the Council have thought desirable to print in full, and it will be found appended to this Report.

On the 15th, the Association met at eleven o'clock, when the following papers were read and discussed.

On the "Statistics of the Deaf and Dumb,"	*Dr. Scott.*
„ "Bovey Lignite Deposit,"	*W. Pengelly, Esq., F.G.S.*
On the "Relations to Literature of a Provincial Association for the Advancement of Literature, Science, and Art" ..	*Rev. J. E. Risk, M.A.*
On a "Sand-bed at Bovisand, Plymouth,"	*Spence Bate, Esq., F.R.S.*
„ "The Ferns of South Africa, and a comparison of them with the Acrogenous Plants of Great Britain and N. America."	*W. S. M. D'Urban, Esq.*
„ "Age of the Dartmoor Granite." ..	*W. Pengelly, Esq., F.G.S.*

Abstracts of these papers have been kindly furnished by their respective authors, which will be found to follow the President's Address. In the evening, the Members were entertained at a Conversazione given by the Devon and Exeter Graphic Society, where they had the opportunity of inspecting a large and choice collection of Works of Art, solely by Devonshire Artists; a variety of interesting objects of Natural History, and some rare and valuable Microscopic and Spectroscopic illustrations.

The last day of the meeting was devoted to a visit to that most interesting locality, the Bovey Heathfield, under the able guidance of William Pengelly, Esq., who had read a paper on the previous day on the Lignite Deposit found at this place.

The Council feel that the best thanks of the Association are due to the Committee of the Devon and Exeter Institution, for having permitted them to meet in their spacious Library for the transaction of the preliminary business of the Exeter Meeting.

The Council congratulate the Members on the prosperous financial state of the Society, which will be seen by the Treasurer's account accompanying this report. The Bye-Laws of the Society, passed at the Exeter Meeting, have been printed, and are now also appended.

It having been determined that the next Meeting should be held at Plymouth; SPENCE BATE, ESQ., F.R.S., &c., was elected President; JAMES DABB, Esq., Local Treasurer, and J. BROOKING ROWE, Esq., Local Secretary.

The Council cannot close this report without again recording their satisfaction at the successful manner in which the proceedings of the first year have terminated, and hope, that at no distant day, the efforts of the Association will have been such as will make them universally acknowledged as having been highly instrumental in fulfilling the objects the Association has in view, viz.,—The advancement of Science, Literature, and Art, in Devonshire.

The Treasurer in Account with the Devonshire Association for the Advancement of Literature, Science, and Art.

1862.	£.	s.	d.		£.	s.	d.
Local Secretary, Incidentals	4	5	6	Members' Subscriptions	26	10	0
Mr. Parfitt, Issuing Tickets	2	0	0	Associates' Tickets	3	15	0
Use of Rooms	7	12	0	Ladies' ditto	1	17	6
Printing and Advertising	9	0	9	Excursion ditto	8	11	0
Stationery	0	8	7				
Coach Hire and Refreshments for Excursion to Bovey	5	14	0				
Balance	11	12	8				
	£40	13	6		£40	13	6

Audited and found correct, { W. R. SCOTT. R. T. ABRAHAM.

Signed, WILLIAM VICARY, *Treasurer.*

THE PRESIDENT'S ADDRESS.

Ladies and Gentlemen,—May I not inaugurate this Association by a question and answer from the Poet Laureate?

> "Who loves not knowledge? Who shall rail
> Against her beauties? Let her mix
> With man and prosper. Let her fix
> Her pillars,—let her sway prevail."

And in furtherance of this object we are now assembled together; the thought which occupies my mind, and which I have no doubt is occupying yours, may be found in the word "progress." Our great instructor, Bacon, who emancipated this nation from the trammels of the Past, and taught it courageously to think and to speak,—proclaimed a noble maxim? "Let observation be fertile; let authority be barren." Don't ask what is come down to us from the ages of ignorance, but examine for yourselves. *Fiat experimentum!* was the foundation on which he raised his philosophy. It is this spirit of inquiry which has made us all what we are, and I would here say on the threshold, that it is a privilege as a Christian nation, to know and to feel that genuine Christianity has never opposed itself, and never could be opposed to the teachings of science; that it has been its handmaid and helper; that our religion has not been a stationary religion, but has been strengthened and invigorated in all its essential characters by the advance of civilization. Among Christian nations have been found the most exalted intellects,—the men who have marched at the very head of our race,—generation improving generation—inquiry aiding inquiry, till we have gradually reached the noble position that we now occupy. Our religion not only justifies —it encourages and commands inquiry. We know that all truths must harmonise. We know that science is only one

of the great revelations of God. We know that nothing is true but what is sound, and wise, and will bear examination. To shun examination—to deprecate inquiry—is to shew an inner conviction that our opinions are built upon sandy foundations. I often recollect a conversation which I had with one of the most remarkable living personages—the first king of Siam. He is at the head of the Buddhist religion, and the Buddhist religion is professed by a far greater number than any other. At this moment, probably, more than five hundred millions of our race are attached to some of the forms of Buddhism. The observation of the Siamese monarch, so emphatic from the source whence it came, was this:—"If I found doctrines in Buddhism opposed to the discoveries of philosophy, I must believe that such doctrines form no part of a divine revelation. I can judge of those discoveries, and I *will* judge of them; for I know only that portion of my religion can be true which is consonant to, and agrees with the teachings of European philosophy." We, too, can well afford to make the same confession, and be proud to occupy the same impregnable position. We may pursue truth wherever it leads, and fear nothing, for if we pursue it in a conscientious spirit and in the love of truth, be assured we cannot be led far astray. Difficulties, it is true, are associated with inquiry—with every step we take in the pursuit of knowledge. Our meeting to-day is an experiment in which we mean to succeed. One of our most earnest, and most able friends here has said emphatically to us all, "No discouragement—no despairing." And why should we be discouraged—why should we be desponding? The greatest works have small beginnings; the most ennobling discoveries have emanated from a single thought; the longest journeys must be begun by a step, and it is only little by little that we can reach important results.

> "The wise and prudent conquer difficulties
> By daring to attempt them. Sloth and folly
> Shiver and shrink at the sight of toil and danger,
> And make the impossibility they fear."

In this spirit I trust this Association starts, and will move forward. I hail this meeting with congratulations. I have always believed that this part of the world, which has furnished its contributions to everything that is illustrious in our country, would not be backward in the movement that agitates the whole community. Devonshire has not been wanting, in any period of modern history, in producing its share of illustrious men. When "Westward Ho!" was heard

in this region, Queen Elizabeth found here some of her most adventurous, her most distinguished heroes. Among the earliest poets in ancient times, the "Swan of Isca" was heard, and sure I am, that in contributions to the fine arts, we shall not be found wanting. It is impossible to look upon what is passing in the world—to witness "the great stream of tendency," without some desire to partake in its triumphs and to share its glory, to move on while all around us are moving, to do something while others are doing much. Many who are present, I have no doubt, have seen the grand Exhibition in London, with its accumulated and amazing wonders, which have made every Englishman proud while he walked amidst that extraordinary display which has been so beautifully described by Tennyson:—

> "——— through long laborious miles
> Of palace. Through the giant aisles,
> Rich in model and design,
> Harvest-tool and husbandry,
> Loom and wheel machinery,
> Secrets of the sullen mine;
> Steel and gold, and corn and wine,
> Sunny tokens of the Line;
> Polar marvels, and a feast
> Of wonder out of west and east;
> And shapes of hues and part divine,
> All of beauty, all of use,
> That our fair planet can produce;
> Brought home under every star,
> Blown home over every main,
> And mixt, as life is mixt with pain,
> The works of peace with works of war."

Entering upon such a subject, how vast is the field of research and inquiry. We start from this our world, of which so much remains to explore. We have looked over its surface; we have gone a certain way into its depths, where we meet impassable barriers which arrest our progress. A very remarkable paper lately read by Mr. Fairbairn, shows what is the increasing heat as you descend into the bowels of the earth. I believe that there is scarcely any mine in this country which is more than one mile in depth, if there be any so deep. At the distance of two and a half miles from the surface, it is found by calculation that the heat is that of boiling water—212 degrees. If you could descend 40 miles—and how far removed from the centre of the earth that is you know—you would find a heat that keeps all metals and minerals in a state of constant fusion; and what must be the intensity in penetrating further! You ascend to

the surface—what wonders you find there! Look for a moment at that mass of black and sleeping coal. Inquire what a few generations ago a man would have thought who contemplated that heavy, inert heap. He had no notion of its origin. It never could have occurred to him that ages and ages gone by, there had been primeval forests which had passed away under the influence of time, and that they were to leave the deposits by aid of which future generations should work the wonders that we see now accomplished by cheap machinery, set in action by the power of steam. Who could have believed that that piece of "black earth," would in process of time almost revolutionize the world of labour. We move from the surface of the earth, and how imperfect is our knowledge of the atmosphere that surrounds it! How unobservant most of us are! To our artists belong the special study of nature; yet in landscape painting the essential characteristics of clouds are frequently unnoticed, and it seems to have occurred to few of them that every cloud is fashioned by some law, that there is no form of cloud which is not arrangeable under certain conditions of harmony and order. In boyhood I had the privilege of conversing with Luke Howard—the first man that wrote on the laws of the clouds—and he told me that his pleasure in looking at many pictures was destroyed, because the clouds represented in them were such as never existed. Not long ago I received a disagreeable impression from the beautiful picture of a very eminent Devonshire artist, in which the entry of Christ into Jerusalem was portrayed, for there I found that he had introduced a number of palm trees, such as were never seen in the Holy Land. The painter had gone to the conservatory of a great nurseryman, and there selected, not for its appropriateness, but for its beauty, a tree known only to the tropical regions of the West. To me, and to others acquainted with Syria, half the charm of the representation was destroyed. Even in a picture now exhibiting, and most deservedly admired, painted by Holman Hunt, Christ is introduced talking to the Jews in the Temple, clad in silken garments, while the listeners are dressed in apparel such as is worn in Damascus at the present day, but was utterly unknown in the period to which the picture refers. Those anachronisms will, no doubt, soon pass away. Painters are becoming more observant; art is entering into the scientific field; and one of our most successful academicians is now making his admirable coast pictures subservient to geological knowledge.

There is no reason why the imaginative and creative power should not be controlled by the severest philosophical study. Michæl Angelo was a constant visitor to the dissecting room, and his works display an admirable anatomical accuracy. All science is associated with all other science. All knowledge is part of one vast scheme of harmony and perfection. "Everything," a German writer has said, "is to be found in everything;" and everything that we acquire assists us to acquire more. Let me refer to one modern example. Before the planet Neptune was discovered, two men of genius—one in France, and one in England—announced contemporaneously, that the movements of the heavenly bodies, explained by the great Newtonic law, indicated the existence of a planet that was undiscovered, and that this planet at a particular moment must necessarily have its existence in one particular locality. Strange to say, at the very time when this discovery was made by French and English philosophers, a German astronomer, looking through his telescope at the very spot indicated, discovered the planet which we call Neptune. "There is," as Humboldt finely observes, "a provision made by Providence that there shall be no obscuration of Nature. There may be darkness here and darkness there; but there is a light which is perpetual and eternal, like that which was worshipped by the ancient Persians, and which never can and never will decay." There is a permanent principle by which the spirit of inquiry is fed, and kept alive, and encouraged by which we move on from stage to stage. To me nothing is more consoling than to compare the present with the past. We know a great deal of the early history of some ancient nations. In China there are records that go back to three or four thousand years, and their veracity is undoubted, because with the history are associated records of eclipses and of the position of the heavenly bodies, so that modern science can test the accuracy of the astronomical facts. You go to Egypt, and there you may study the annals of the Pharaohs in still existing ruins. You may still walk there through the aisle of Sphynxes in the hundred-gated Thebes; you may see to this hour the dress that was worn by, and look even at the skulls of the men who directed the erection of the pyramids. You may go to Athens, and still muse amongst the ruins of the Parthenon, and you may still tread on the stones of the Forum at Rome. In those days long past, what was the state of our country—now undoubtedly the most advanced, the most influential of

nations? We have not an inscription, we have not a coin, we have no one architectural ruin, we have scarcely a reminiscence of Great Britain before the arrival of the Romans in this country. We know not how our ancestors fed; we have reason to believe that they were very slightly clothed; there is no remnant left of their habitations—in fact, all that does remain is a *cromlech* or a *dolmen* or two, which show how very rude they were even in their superstitions. And allow me to say, that the religion of nations always represents their most advanced civilization. To maintain its hold upon the people, religion must ally itself with intellectual superiority; losing this support, its influence must decline and decay. Thus Rome maintained its greatest power, and enjoyed its most honourable and enduring triumphs, when the Church formed its alliances with the restorers of art, called upon them to build its grand edifices, and adorn with the statues and the paintings, which to this hour remain the admiration of mankind. When Michael Angelo, Raffaelle, Dante, Tasso, and other illustrious men founded a new school of learning and of art, Rome was predominant in its influence throughout the world. Let me compare and contrast the condition of this country with what it was in the time of our ancestors. The mightiest nations of past times have all departed. You may go to Tyre and Sidon, and see the lizard creeping upon the overthrown walls. A fishing boat can scarcely enter those ports in which once the commercial navies of the world proudly rode, while we were merely a clan of obscure barbarians. But thanks to inquiry, thanks to science, thanks to progress, thanks to the spirit of adventure, thanks to all that which characterizes a great nation, we have become what we are. And what comforts one most is this, that our civilization has descended to the lowest ranks of society. The meanest amongst us possess multitudes of conveniences and comforts which were formerly denied to the mightiest. Go back to the past, and see where the Roman Emperor trod only upon rushes, for there were no carpets in his palaces; no brilliant gas, no healthy ventilation in his mansions; no scientific appliances for what we now deem the daily wants of life. He lived in what he called luxury, yet his luxury was not equal to that which is enjoyed by the humblest cottager in this country. He had no clock, he had no glass windows, he had few of the comforts which are now accessible to the poorest. Let us see what civilization has done for the home-comforts of the people—light, air, water, food, clothing,

furniture—the cheapness and accessibleness of all these we owe to the diffusion of knowledge, and with the diffusion of knowledge there always goes a demand for something not yet possessed—a disposition and desire to acquire, which is, in fact, the great moving principle of man. It is well indeed to be contented with what we have; it is well that we should not murmur because many things are unattainable to us; but to be always looking onward and upward, to bear ever an "Excelsior" in our minds, ought to be a part of our contentment, as it is a needful element of our happiness. If you travel among tropical nations the least advanced, you will find that all their wishes are fulfilled by the mere local productions of nature. They need not dress the food which the hot sun ripens for them; and clothing they want not, for the temperature is such, that it enables them to enjoy life without feeling the privation of costly garments. There are tribes that do not even build themselves a covering as a shelter from the inclemency of the weather, that have no other protection from wild beasts and reptiles than the trees in which they sleep at night, and which provide them aliment by day; we know of others that retire as hares and foxes to holes and caverns; we know of people who cannot count three; but the great law of progress is acting even upon the rudest, who are gradually raised in the scale of man, or utterly superseded and extinguished as they come in contact with other races more adventurous and more enlightened. There have been lately curious discoveries, which lead us to believe that animals much resembling man existed long before the introduction of the human race. There has lately been exhibited a skull found in the bed of the river Trent—a skull having the intellectual characters which distinguish the human species, but showing that the being to which it belonged could not have walked erect. Professor Owen says, that if other such skulls should be found, he should consider that it was not a malformation, the result of disease, but as affording irresistible evidence of the existence of an inferior race that may or may not be called man, and that probably walked on all fours. I scarcely know in which direction first to turn, in order to call your attention to the great results of progress and inquiry. There is no science whose developments do not exhibit a marvellous change. Look at the medical art. In what a rude way in former times surgical operations were performed; how many of them were attended with extreme danger, which now are accomplished in perfect safety. Consider how human suffering has been

diminished by the introduction of chloroform, under whose influence, as you know, the most difficult operations may be undertaken, the patient remaining insensible to those of the most perilous and the most painful character. How many diseases are cured now, which in ancient times were considered of an utterly hopeless nature. How all these combinations have added to the average term of life. There has been everywhere remarkable progress. I know nothing that characterizes it more than the history of languages. Languages are multitudinous. There is an erroneous impression as to their number. In one catalogue there are 7,000 languages named, and that is, perhaps, a small proportion to those which have been, or may be spoken. There is a small territory in Africa, where there are more than three hundred separate and distinct languages. In this country there were five or six languages used within the memory of man—one of them, the British, the ancient tongue of the West of England, which was understood in Cornwall in the last century, has passed away; the Welsh is dying out, and in some Cambrian provinces exists no longer; the Erse is gradually but rapidly invaded by the English; the Manx has been almost wholly extirpated, and the Gælic is also perishing.

Among the great results of civilization will be the reduction of languages to a few, and it is a matter of congratulation that our Anglo-Saxon tongue is one of the strongest, noblest; rich, yet ever welcoming new combinations and new contributions, it is likely to become the most extended and influential language in the world. It is planted in every region of the earth—it is the representative of the highest civilization. A great German philologist congratulates the world on the fact, that the commercial influence of England produces throughout the world the means of communication by the most efficient and the most powerful instrument of language that has ever existed. Of the languages in France, I recollect it being stated by an eminent man who was in the convention of 1789, that only five or six million then spoke French, and this moment there are only five or six million who do not speak French. In Spain, almost all the provincial languages are absorbed in the Castilian. Luther created the language of Germany—when he translated the Bible into the Saxon dialect of the Teutonic. All progressive and improving languages are the evidences and the aids of progress—the imperfect idioms of the world are dying out. There are many spoken only by small clans of 100 or 200 human beings, and these are so useless, that as

soon as these clans come in contact with others, a more extensive language is created, and so, little by little, language is enriched and diffused.

Among the more prominent causes of general improvement, is the devotion of thought and study to special objects; there is a concealed fallacy and error in the often quoted poetical dictum:

> "A little knowledge is a dangerous thing,
> Drink deep, or taste not the Pierian spring."

A little knowledge is assuredly less dangerous than none, and a small draught even of poetry, is more grateful than absolute drought. Still, it is a heavy reproach to say of any man, that he knows a little of everything—much of nothing—and perseveringly to cultivate a particular portion of the field of inquiry is the surest way to success.

A great deal of attention has been lately paid to the subjects of light and of heat. I do not now speak of their value to society, but the extraordinary discoveries that have been made with reference to these wonderful elements fill us with amazement, and show us, whichever way we turn, that the whole world is one great miracle, a marvel of science; admirable and perfect alike in all that is great—in all that is small; if anything can be called small in the vast treasures of creation. It was a beautiful discovery when a ray of light was divided into its primitive elements—that the rainbow was found to be a magnified display of the colour of which every single ray is composed—forming a pure white in the union, and leaving darkness in the absence of all. But of late, discovery has gone much further; and we find that the sun, when it sends forth its rays, which reach to the extremity of our system, and, perhaps, beyond it; that the sun is pouring out in every ray, not only all these splendid colours, but a vast amount of metal in fusion, whose qualities and whose characters have lately been ascertained, and which can be shown separately and distinctly by the aid of the Spectrum. If we inquire into the advantages derived by the community from the discoveries of science, who can forget what has been done for facilitating communication—communication which, in my mind, represents civilization, and is, in fact, one of the most humanizing results of civilization. Cheap postage; railways; steamboats. What subjects for congratulation! I have lived in a country where it required five weeks to convey a message from the frontier to the capital, and it was not long ago that at the Polytechnic

Institution in London, I saw questions sent to Paris, to Vienna, to Petersburg, the answers of which were received while the company remained gathered together. The Electric Telegraph! what wonders has it not exhibited! When the electric telegraph was first introduced into China, I invited some of the principal Mandarins to be present at its early operations. I requested them to send some of their officers to the extremity of the wire, with whom they might hold intercourse. There was a great deal of discussion among them, and they thought we must have great tubes through which the communication was made, and that as a cannon-ball is sent from one locality to another, in that same manner were our messages conveyed. When they ascertained that this was impossible, that the distance was too great to justify such a theory, they merely turned round and said, "We are certain that you have communications with infernal spirits, for what you do could never be done unless the devil came to your aid." This was very natural, yet things might be represented to them, even more mysterious than that, connected with the photographic art. This art was one of those, which, as a poet has said:

> "Give to a moment of our fleeting time
> The appropriate calm of blest eternity."

Why that art can perpetuate the foam upon an ocean wave, it can arrest upon paper a flying steed on the race-course, and it has done things more wonderful still. In a spot not larger than that covered by the point of a pin, the Lord's Prayer has been written, and in the thirteenth part of a square inch, the whole of the Bible and New Testament has been imprinted, every word and every letter of which may be read by the aid of the microscope. I said that we ought not to be discouraged by difficulties; and when you consider what man will do in the pursuit of wealth, you may well ask whether in the interests of science, in the interests of something higher and nobler than wealth, he should not exert himself. What dangers will he not brave when he seeks to enrich himself! the frozen Artic or Antartic he will explore for oil; he will confront the fiery tropics for drugs and spices; he will dig in the deepest darkness for metals and minerals; he will dive into pestiferous forests for wood and gums; the most solid substances he will convert into gas, the most subtle into solidity. Nothing in truth but the restraint of a higher intelligence bounds his ambition! Man can remould, but he cannot create; he can give a new disposition to

elementary matter, but he cannot make an atom; he can build a monument, but he cannot raise a mountain; he can scoop out a canal, but he cannot pour forth a river. In the sphere which is accessible to our faculties, there should be no restraint upon investigation; we must not be deterred in doing what we can do, because we cannot accomplish everything. Now let us look for a moment at some of those arts which have principally benefited the people, and by which science has been popularised for the interest of the multitude. There is in this city a remarkable collection of Anglo-Saxon manuscripts. We have, I believe, a list of all the books possessed by one of the first Bishops of Exeter. I think that the whole number of volumes that the library contained was 70 or 80, and it was deemed a rich collection; and no wonder, for an elaborate manuscript nearly cost a life-time in its preparation. Books were wholly inaccessible to any but the rich; and of the rich, beyond the clergy, there were few who could read. Comparing that state of things with that which now exists, what a difference we observe. There is many a penny newspaper of which 200,000 or 300,000 copies are printed, and, perhaps, there is not one single penny newspaper which does not contain more valuable information, accessible to the poorest, than is to be found in the whole library of the most learned, or the most opulent man before the Conquest. See what engraving has done for the diffusion of the love and the appreciation of art among the multitude—wood engraving especially—it is so cheap and so efficient, and it is so valuable as a source of employment, that many, without the assistance derived from that art, would have been in a state of destitution. As an instance of this, a single wood engraver of my acquaintance employs no less than 200 young women, most of whom are the orphans of clergymen. Let me mention a circumstance connected with this locality. A gentleman who knew me in my boyhood, and who has fallen into extreme poverty, born in this city, and in a very comfortable station of life, had given a good education to his daughter. She learned to draw; she had been employed by an artist in London for engraving on wood, by which work she was soon enabled to earn from one to two guineas per week, and she maintained her family, and is this moment maintaining it, by the exercise of her talent in a profession, that only a short time ago had scarcely an existence. Another popularised art to which I would refer, is that of sculpture. It must be in the recollection of almost everybody, that the ornaments

of our cottagers were painted plaster of the rudest shape; yellow parrots; spotted cats, that shook their heavy heads in their hollow necks; exhibitions of which savages might be almost ashamed; while, at this moment, casts of the noblest works of Thorwaldsen and Canova are hawked in the streets, and ambulatory teachers of art, not forgetting very tolerable musicians who have replaced the vile old ballad singers, are met wherever you go. You scarcely enter the cottage of a labourer, without seeing some evidence of the manner in which art is made accessible to the multitude, and serves not only for the enlargement of their minds, but for their daily enjoyment. Consider the power of locomotion in regard to travelling. When the journey to London was undertaken in former days, it was a business of long preparation and discussion, not accomplished without danger; and when the happy adventurer had safely returned to his home, his visit to the Metropolis constituted an era in his life, and in the domestic history of his family; but now, thanks to our railways, we can take our breakfast in Exeter, go to London, transact our business, dine there, and return at the end of the day to our bed and repose. Among the changes that have taken place, I have been much struck with the disappearance of ancient superstitions and prejudices. The belief in witchcraft was almost universal in this county; still, some fragments are left; but it would be very difficult to find a considerable number of persons who still indulge in the strange theories which occupied the minds of our ancestors; and yet I witness the passing away of some of our poetical, and by no means pernicious traditions, with some regret. The other day I visited a spot familiar to me in my boyhood, where I was accustomed to look at a granite basin in which the pixies were said to bathe, and where little green circles still exist—the mossy carpets on which I was taught to believe the pixies danced at the full of the moon, after playing all sorts of wicked tricks with the peasantry in this neighbourhood. The very memory of these things is departing, but they are being replaced by something better. Everywhere, there are marks of improvement. The people are more and more instructed, their aspirations are higher, their comforts are greater, there is everywhere a diminution of crime; while the ancient barbarities of our criminal code have been replaced by a kindlier and wiser legislation. It is within my recollection that there was scarcely an assize in this county at which six or eight persons were not sentenced to execution and hanged.

When the county gaol was built, it was believed that it would be far too small for the unfortunate prisoners that would be committed to it. Now we have reached a time in which the population is doubled, yet that gaol is far too large for the necessities of the county. In the meantime, too, we have gradually grown in opulence. The results are marvellous, when they are looked at in their amalgamation. Who would believe that since the year 1815 about six thousand millions sterling have been added to the national property! The time was when it was thought that the national debt would never be paid by all the wealth of the country. The national debt is now probably but one-tenth part of the country's possessions. Perhaps, it may be thought that these facts have no bearing on the subject which brings us together, but it appears to me that all knowledge is valuable, and statistical knowledge is not less valuable than other knowledge. Among the objects which I trust will occupy the attention of this Association is our county history. There are abundant materials scattered abroad, but no gathering of them together in a creditable, still less an attractive shape. A complete, if not an exhaustive work is sadly wanted. Of many counties there are admirable collections of all that is known, and local societies are doing much for this interesting object. Let me make a passing reference to the Ordnance Survey as now in progress. Its latest publications not only exhibit every building of interest, but every spot; every tree with which any striking historical event is associated. Our maps by and by will become full of instruction as our books are. In truth, we are entering upon that state of things which our Shakespeare has described, and

> "Find tongues in trees, books in the running brook,
> Sermons in stones, and good in everything."

In conclusion, the President apologised for the desultory character of his extemporaneous address, regretting that his shattered health had not allowed him adequately to respond to the flattering invitation which had given him the opportunity of addressing them.

"If," he concluded, "in this wandering discourse, any knowledge has been conveyed, any material furnished for reflection, any service rendered in furtherance of the objects which have brought us together, I shall be amply recompensed."

ON THE

STATISTICS OF THE DEAF AND DUMB.

By Dr. Scott,

Head-Master of the West of England Institution for the Deaf and Dumb.

Any investigations into a disease, which produces such important intellectual, moral, and social results as that of deaf-dumbness, must always have many points of interest, both for the philosopher and the philanthropist. It is with this belief that I have ventured to bring before you, on the present occasion, a consideration of the Deaf and Dumb.

In considering the subject, it will be convenient to do so under the following heads:—

First, as to the numbers of persons suffering from this affliction. Secondly, the distribution of these so suffering. Thirdly, the causes of the disease; and, fourthly, the intellectual and moral condition of the deaf and dumb, and its improvability.

First, then, until the census of 1851, little accurate information had been obtained as to the exact numbers of deaf and dumb persons in the United Kingdom. Gentlemen interested in the formation of institutions for their education, had previously—chiefly through the clergy—made, in some localities, attempts to collect statistical information on the subject, and, to some extent, succeeded; yet, still the information was vague, and it was felt that no great reliance could be placed upon inquiries conducted so loosely and desultory as those must necessarily have been; so that, until the period before named, our statistical facts connected with this disease were few and uncertain.

Tables, exhibiting the numerical proportion of the deaf and dumb to other persons, had been published previously to this in different countries of Europe; and in Belgium, Dr. Sauveur, so early as 1835, commenced to investigate the subject, the results of which investigations he published in 1847.

In the 1851 census we got a considerable amount of infor-

mation; but the best account this country has yet produced, is that published by the Commissioners in their report of the status of disease in Ireland. In this report, written by Professor Wilde, under whose direction the inquiries had been chiefly conducted, we have very elaborate and carefully collected information, and in no country has the subject been more effectually treated than it is here. Of this report I have not hesitated to make use in my present paper.

Throughout the whole of Britain we have a proportion of one person deaf and dumb to 1738 who are not so afflicted; in Scotland, one in 1340; and in Ireland, one in 1307. Table I. shows these figures more prominently, and also gives the proportion of deaf mutes throughout Europe.

TABLE I.

PROPORTIONS OF DEAF AND DUMB TO THE POPULATION.

In all Europe	1 in 1,593.
In England and Wales . . .	1 in 1,738.
In Scotland	1 in 1,340.
In Ireland	1 in 1,307.

We see from this table, that, taken generally, the deaf and dumb average throughout Europe about one deaf mute to every 1600 persons nearly—a much larger number than is generally supposed. With regard to the sexes, the males are found to preponderate over the females, as shown in Table II.

TABLE II.

PROPORTION OF SEXES.

England and Wales . .	121 males to 100 females.
Scotland	125 males to 100 females.
Islands of British Seas .	121 males to 100 females.
Ireland	100 males to 76 females.
In Devon	100 males to 82 females.
In Dorset	66 males to 60 females.
In Cornwall	100 males to 92 females.
In Somerset	100 males to 92 females.

In Great Britain, then, we may say that 12,553 persons have been returned as deaf and dumb (6,884 males, and 5,669 females). Of this number, 10,314 are in England; 2,155 in Scotland; and 84 in the Islands of the British Seas. The whole number of deaf and dumb in Europe is estimated at 250,000.

In considering our next division of the subject; viz., the distribution of the disease, we are made acquainted with

some remarkable facts. It would only be reasonable to suppose, *a priori*, that this complaint was spread over the country pretty equally, and that, if there were places where it predominated most, we should find these to be the narrow alleys and crowded streets of large and populous towns. The fact, however, is diametrically opposite. It is not equally distributed over the country, and it prevails most in agricultural and pastoral districts.

By looking at Table I., it will be seen that Scotland and Ireland suffer more from the disease than our own country. While, if we descend to a more detailed examination of its distribution in England, we find the same principle prevail; viz., that in the less populous districts, the deaf and dumb are the most. Table III. shows the proportion in different parts of England and Scotland.

TABLE III.

In London	1 in 1783.
South Eastern Counties	1 in 1948.
South Midland "	1 in 1902.
Eastern "	1 in 1665.
South Western "	1 in 1393.
West Midland "	1 in 1610.
North Midland "	1 in 1750.
North Western "	1 in 2014.
Yorkshire "	1 in 1717.
Northern "	1 in 2058.
Welsh "	1 in 1542.
SCOTLAND.	
Southern Counties	1 in 1480.
Northern Counties	1 in 1156.

In the parishes contained by the union of Crediton, a very rural district in our own rural county, we find the proportion to be, one in 1,142 persons; while again in the Scilly Islands, we find that out of 2,677 persons, there are six deaf and dumb, or one in about 446.

This variation in the prevalency of this disease is not confined to Britain; it also prevails over the continent of Europe.

We next come to the consideration of the causes of this disease. Recently the subject has been invested with new interest. In a paper read at the late Social Science Meeting, a French physician attributes much, or all of it, to marriages of consanguinity. Many of our newspapers have taken up the question, as if the fact of marriages of con-

sanguinity, having a tendency to produce deaf-dumbness, was a new discovery. This is far from the truth. In a work published by me on the subject, in 1842, it was there fully entered into, and it was then far from being a new idea. Dr. Baudin, however, has gone further in his statistical inquiries than any one that has hitherto written on the subject, since he examines into the prevalency of the disease amongst different religious bodies, &c., which had not before been attempted.

According to the statistics of our country, the following are the three causes to which muteism has been chiefly attributed.

1st. Fright, experienced by the mother while pregnant.

2nd. Too close consanguinity; or, the inter-marriages of near relatives.

3rd. Family peculiarity and hereditary taint.

There is no teacher of the deaf and dumb who has not heard fright attributed as a prolific cause of the disease; and 127 instances are recorded in the Irish reports of this as a cause of the disease. We know that there are many kinds of disease, which have been attributed to fright, or strong and sudden mental emotion, such as hair-lip, club-foot, idiocy, &c. This cause is, however, difficult accurately to determine, and we depend more upon the *ipse dixit* of the parent, than upon any light that can be thrown upon it by minute analysis.

2nd. The too close consanguinity of parents has long been looked upon as a very predominate cause of the disease, and I think that evidence enough has been collected to show that it is so. Indeed, I think it is to this cause that we must look for an explanation of the remarkable results already alluded to, in the difference of the prevalency of the disease in different places.

After some thought, and a careful examination of the subject, I am inclined to think, that one of the main features of difference amongst the inhabitants of such places is, that in districts where the deaf and dumb prevail most, there is little movement or change amongst the inhabitants; while in districts where such persons are fewest, we find a population of a migratory character. In the former case, breeding in and in goes on for generation after generation; while in the other it does not, new blood being supplied by the frequent changes taking place among the inhabitants. All who are acquainted with agricultural parishes, can at once point to certain names which predominate there, and which have

predominated there for generations. But this is not the case in large manufacturing towns, many of which, indeed, have only risen up into existence within the last century, and have been peopled with persons coming from every corner of the island; not to mention others, and these are not a few, who might write their birthplace at any point between the Elbe and the Archipelago.

I have given some attention to the investigation of this subject, and have endeavoured to discover differences in soil, climate, and other such like modifiers of human health and disease, but have failed to find any cause that would appear to be so constant in acting upon places freed from this disease, as that of frequent changes amongst the population; and, on the other hand, where the disease most developes itself, we find a population little liable to change or fluctuation.

In our own district, extending over the four counties of Devon, Cornwall, Somerset, and Dorset, I even examined the occupations of life to which the parents of deaf and dumb children had been accustomed, thinking it possible such causes might, in some degree, operate in producing the disease; but I failed to find out any appreciable difference in this direction. Each trade only giving its proportion of deaf and dumb to the proportion of persons employed in it.

Again: In the Irish report there are no less than 170 cases recorded in which the parents were related in the degrees of either first, second, or third cousins. I think these facts shew clearly enough, that the belief in marriages of consanguinity producing deaf and dumb children, is not without strong evidence in its support.

The third cause to which this disease has been attributed, is that of family peculiarity and hereditary taint. A strumous taint has long been supposed to predispose to congenital defects, and is believed to influence the malady under consideration.

The tendency it has to run in [illegible], is shown by the frequency of two or three childr[illegible]cted oc[illegible]n the same family. The experience [illegible]ution I have the honour to preside she[illegible]

The following is an extract fro[illegible]ttee's [illegible] this subject:—

175 cases with only [illegible]
26 cases with 2 [illegible]
12 cases with 3 [illegible]
4 cases with 4 [illegible]
1 case with 5 [illegible]

There can, then, be no doubt that a hereditary taint, or family peculiarity, is another source of transmitting this disease. Besides the congenital or born cases of deaf-dumbness, there are also those which are acquired after birth, arising from various diseases. The proportion which these acquired cases bear to those which are congenital, is about one to 8·43. The complaints which most commonly cause deafness, are mostly those which occur in childhood. The experience of the West of England Institution in this respect is given here.

After Typhus and Scarlet Fever . . .	16
„ Teething	5
„ Measles	2
„ Convulsions	3
„ Hooping Cough	1
„ Hydrocephalus	1
„ Inflammation of Brain	1
From doubtful causes	30

We have now, as lengthily as the occasion will permit, glanced at the physiological view of our subject; but before we conclude, the question may be asked, Is deaf-dumbness curable? To this serious question, I regret to say, experience answers, It is not. There is no evidence, that I can find, of a true case of congenital deafness ever having been cured; and those who lose their hearing so early in life as never to have learned to speak, come under the same category. Several cases of reputed cures of deafness exist, but they will not bear the test of close examination. This being the case, nothing remains for the amelioration of this afflicted class of our fellow-creatures, but to attempt, in some way, to improve their condition by intellectual and moral means. The question then arises, Can their condition by any means be improved? can they be educated? Here it is a satisfaction to think experience answers that they can. From the moral point of view, the uninstructed deaf mute presents a melancholy picture, and claims the special attention of the philanthropist, and the protection of every one of his fellow-men to whom Providence has vouchsafed the full power and use of the various faculties of sense and reason. Owing to the forlorn condition to which he is reduced by his affliction, he has the greatest difficulty in expressing his commonest wants; he is unable to educate himself, or receive instruction, through the ordinary channels of education; he is constantly exposed to the temptation of crime, from the defect of moral training,

and from having no just idea of right and wrong, he often becomes highly dangerous to society. Degraded by his uncontrolled passions, he is, moreover, frequently the victim of cruelty and injustice; and being incapable, without education, of properly understanding or duly appreciating the truths of religion, he is reduced to a condition but little elevated above that of the brute creation. Alone in the world, his faculties undeveloped, and shut out by his unhappy circumstances from thoroughly communicating his ideas to the rest of mankind, the deaf mute, in an especial manner, claims the care and sympathy of every one. We have said, that the deaf and dumb can be educated, but we cannot here enter into the history, or indeed the plan, of deaf mute instruction. However, by the labours and ingenuity of persevering and benevolent men, a mode of instructing them has been devised, by which they are made, more or less, according to their different capacities, capable of understanding and performing their duties as moral and responsible agents, and as members of a civilized community.

From the last information we have on the subject, it is stated that there are 194 schools in the world, supplied with 449 teachers, and about 7,000 pupils receiving instruction. There are in the British Islands, 22; in France, 41; in the German States, 28; Austria, 10; Italy, 11; Prussia, 25; Belgium and Holland, 10; Bavaria, 10; Denmark, Norway, and Sweden, 5; Switzerland, 10; Russia and Poland, 2; the United States, 13; Canada, 1; Spain, 2; Portugal, 1; Asia, 20. In the British Isles the period of instruction varies, but averages about five years—too short a time for the requirements of the case. A few of the industrial arts are taught in some of the Institutions, but these are giving way to apprenticeships with masters, as it is found that not much difficulty is experienced to give an educated deaf mute a knowledge of an ordinary trade. I feel I have already extended this paper beyond the limits which the time of the Association can afford to the subject, and shall conclude my remarks with simply directing the attention of all interested in the cause of suffering humanity to the sad condition of the deaf mute; and, as he has no voice himself, to excite sympathy in his behalf, or plead his own case with the benevolent, I trust my remarks, by extending a more general knowledge of his true state, may be the means of procuring for him a more general sympathy, and a more extended help.

THE LIGNITES & CLAYS OF BOVEY TRACEY,

DEVONSHIRE.

By W. Pengelly, Esq., F.G.S.

The little town of Bovey Tracey nestles at the foot of Dartmoor, very near its north-eastern extremity; it is situated on the left bank of the river Bovey, about two miles and-a-half above the point at which it falls into the Teign. A considerable plain stretches away from it in a south-easterly direction, having a length of about six miles, from a point about a mile west of Bovey, to another about as far east of Newton; its greatest breadth is about four miles. It forms a lake-like expansion of the rivers just named, especially the former. That portion of it immediately adjacent to the town is known as *Bovey Heathfield*, and measures about 700 acres.

On its west and north-west rise the lofty granite hills of Dartmoor, with their border of metamorphic rocks; on the north the trappean elevations of Hennock; on the north-east and east the Greensand of the Haldons, and the trap and limestones of Chudleigh and Kingsteignton; and on the south the traps, limestone and associated rocks extending from Newton towards Ashburton.

The plain may be said to be continued, in a narrow southerly prolongation, from Newton to near Kingskerswill.

Shafts and other excavations have shown that the deposits in this basin consist of an accumulation of coarse gravel, mixed with sand and clay, unconformably overlying distinct strata of lignite, clay, and sand, which are familiar to geologists as the *Bovey Deposit.*

The most important of the excavations is that known as the "*Coal Pit,*" situated on the "Heathfield," somewhat less than a mile from the town, and about the same distance from the western margin of the deposit. It is an open work, nearly a thousand feet long, about 340 feet wide, and 100 feet deep.

Subterranean workings have been carried on extensively, by means of galleries opening out of the pit at the bottom. One of these is 190 fathoms long, and is very nearly in the direction of the *length* of the pit.

The attention of both the scientific and commercial world has long been called to this deposit, and several accounts of it have been published. Many of these contain speculations and discussions, respecting the origin, accumulation and age of the formation, which may be said to have resulted in a settled conviction that the lignite is of vegetable origin, that the clays and sands were derived from the granite of Dartmoor, and that the whole is of supracretaceous age; and a general belief that the plants had not grown on, but had been transported to, the area they now occupy. The exact chronology of the formation was by no means agreed on, further than that there seemed to be a prevalent, but vague opinion that, geologically speaking, it is very modern. The only definite expression that had been given on the question, was the provisional one that the deposit belongs to the Post-Pliocene epoch. This was based on a cone said to have been found in one of the uppermost beds of lignite, and which was identified by Dr. J. D. Hooker as belonging to the Scotch fir. This and some small seeds described, also by Dr. Hooker, under the name of *Folliculites Minutulus*,* were the only identifiable fossils which, prior to 1860, had been found in the Bovey beds.

In the year just named, Dr. Falconer introduced the subject to Miss Burdett Coutts, as one which, for the credit of British Geology, it was eminently desirable to have very fully investigated. Miss Coutts, with characteristic liberality, furnished me with means to undertake the work; I received the most prompt and cordial co-operation from the proprietor, John Divett Esq.; and was so fortunate as to secure the services of Mr. H. Keeping, the well-known fossil collector of the Isle of Wight.

In order to accomplish the two-fold object of collecting fossils and ascertaining the stratigraphical order of the deposit, it was decided to make a fresh section; in fact, to cut a series of steps, on a large scale, by which to descend the face of the artificial cliff of the "coal-pit" from top to bottom. As we descended, the thickness of each bed and the amount and direction of its *Dip*, were carefully measured. The results of this systematic exploration are given below.

* *Quart. Journ. Geol. Soc.* vol. xi. p. 566, &c.

Section of the Bovey deposit, in the south wall of the "Coal-pit," near its western end. Dip 12½° towards S. 35° W. (Magnetic.)

Beds.	Thickness ft.	Thickness in.	Totals ft.	Totals in.	
1	7	6	7	6	SANDY CLAY, with a large number of angular and subangular stones, locally termed "*Head.*"
2	2	6	10	0	CLAY. Plastic. A few fragments of lignite.
3	6	3	16	3	SAND. Quartzose.
4	2	9	19	0	CLAY. More or less dark, approaching to black.
5	0	7	19	7	LIGNITE. Woody and brittle.
6	0	11	20	6	CLAY. Very dark. Contains much broken lignite.
7	1	3	21	9	LIGNITE. Woody in some places, in others fossiliferous.
8	0	5	22	2	CLAY. Dark. Some broken lignite.
9	2	0	24	2	SAND.
10	2	0	26	2	CLAY. Tough-Light colour. Contains patches of sand and some broken lignite.
11	0	8	26	10	SAND. Sometimes cemented into a grit.
12	2	6	29	4	CLAY. Variable in colour. Contains broken lignite.
13	1	0	30	4	LIGNITE. Woody, loose, and brittle.
14	2	9	33	1	CLAY. Sandy and brittle. Contains broken lignite.
15	0	7	33	8	LIGNITE. Woody, loose, and brittle.
16	4	0	37	8	CLAY. Light colour. Contains much broken lignite.
17	1	5	39	1	LIGNITE. In some parts woody, in others rich in dicotyledonous leaves.
18	2	9	41	10	CLAY. Light in colour. Fragments of lignite.
19	2	1	43	11	LIGNITE. Contains much clay.
20	1	2	45	1	CLAY. Laminated, brittle, and rich in lignite.
21	3	4	48	5	LIGNITE. Hard, brittle, broken. A few seeds.
22	2	0	50	5	CLAY. Dark, rather brittle, coarsely laminated.
23	1	0	51	5	LIGNITE. Contains much clay.
24	1	0	52	5	CLAY. Dark, brittle. Contains a few fragments of lignite.
25	6	2	58	7	LIGNITE. Contains clay, seeds, and rhizomes of ferns.
26	2	1	60	8	CLAY. Light drab. Abounds in fossils.
27	11	1	71	9	SAND. Quartzose, with lenticular patches of clay.
28	5	9	77	6	CLAY. Light colour, rather sandy in places.
29	3	2	80	8	CLAY. Dark. Rich in lignite fragments.

Beds.	Thickness. ft.	in.	Totals. ft.	in.	
30	1	0	81	8	LIGNITE. Rather brittle. Contains ferns.
31	0	8	82	4	CLAY. Very dark. Some broken lignite.
32	0	11	83	3	LIGNITE. Woody, tough, and extremely hard.
33	2	2	85	5	CLAY. Dark lead colour. Contains broken lignite.
34	0	10	86	3	LIGNITE. Very woody, rather tough. Contains seeds.
35	2	2	88	5	CLAY. Dark. Lignite fragments inclined to the plane of the bed.
36	0	1	88	6	LIGNITE.
37	1	11	90	5	CLAY. Dark, brittle, and rich in lignite.
38	0	4	90	9	LIGNITE. Woody and rather tough.
39	0	10	91	7	CLAY. Much broken into angular fragments.
40	1	0	92	7	LIGNITE. Compact, tough, and contains fossils.
41	1	6	94	1	CLAY. Dark, brittle. Contains lignite fragments.
42	0	9	94	10	LIGNITE. Extremely brittle.
43	0	9	95	7	CLAY. Lead colour.
44	0	6	96	1	LIGNITE. Contains veins of clay.
45	0	7	96	8	CLAY. Dark. Fragments of lignite abundant.
46	0	9	97	5	LIGNITE. Very compact and tough. Abounds in seeds.
47	1	4	98	9	CLAY. Dull lead colour. Many pieces of lignite.
48	0	7	99	4	LIGNITE. Compact. Contains seeds and ferns.
49	0	10	100	2	CLAY. Light lead colour. Small pieces of lignite.
50	1	0	101	2	LIGNITE. Compact and tough.
51	0	9	101	11	CLAY. Very dark. A few fragments of lignite.
52	0	3	102	2	LIGNITE. Loose and soft.
53	0	7	102	9	CLAY. Brown. Contains lignite.
54	2	3	105	0	LIGNITE. Compact, tough, and woody. A few seeds.
55	0	10	105	10	CLAY. Very dark blue. Unusually large pieces of lignite.
56	3	2	109	0	LIGNITE. Woody. Frequently has a "charred" appearance.
57	0	5	109	5	CLAY. Blue and brittle.
58	1	8	111	1	LIGNITE. Woody, "charred," and contains a few seeds; none occur where the lignite has the "charred" character.
59	0	4	111	5	CLAY. Colour varying from blue to dark drab.
60	1	8	113	1	LIGNITE. Woody, hard, brittle. Contains seeds.
61	0	4	113	5	CLAY. Blue and dark drab.

Beds.	Thickness. ft.	in.	Totals. ft.	in.	
62	2	4	115	9	LIGNITE. Variable in character. Contains seeds.
63	0	6	116	3	CLAY. Light lead colour. Contains fossils.
64	1	3	117	6	LIGNITE. Very hard and compact. "Charred."
65	0	3	117	9	CLAY. Lead colour. Of resinous aspect. Contains lignite.
66	1	4	119	1	LIGNITE. Similar to the 64th bed.
67	0	2	119	3	CLAY. Of resinous aspect.
68	1	4	120	7	LIGNITE. In all respects like the 64th and 66th beds.
69	0	2	120	9	CLAY. Of resinous aspect, laminated, and brittle.
70	0	3	121	0	LIGNITE.
71	0	1	121	1	CLAY.
72	4	0	125	1	LIGNITE. The "Last bed" of the workmen.

Two other sections were made, both in the south wall of the "coal-pit;" the second, 460, and the third, 680 feet eastward from the first. On comparing the results, it was found that the 9th, 10th, and 11th beds—the first and last being sand, and the second clay—did not occur in the second and third sections, and that in the third section another bed of clay, the 8th or 12th, had also disappeared. The total thickness of the missing beds amounts to about five feet. It was also observed that there was a tendency to attenuation in *the clay and sand beds* eastwards, that is in the direction of the *Strike* of the formation. This is most noticeable in the 27th and 28th beds, which, from being 133 and 69 inches respectively in the first, or most westerly, dwindle to 10 and 7 inches in the third, or most easterly, section.

These facts appear to be confirmatory of the opinion, that the inorganic portion of the Bovey deposit was derived from the debris of the Dartmoor granite.

The sections agree in naturally dividing themselves into three parts or series, viz.—

1st. The bed (No. 1) of *sandy clay*, containing angular and subangular stones (the "Head" of the workmen). No stones of any kind were met with below this.

2nd. The beds from the 2nd to the 27th inclusive, composed of sand, clay, and lignite.

3rd. All the beds below the 27th, consisting of clay and lignite only.

That portion of the age of the deposit which is represented by the first, or lowest, forty-five beds was unmarked by the deposition of sand within that area. Forty-four beds of

lignite and clay, having an aggregate thickness of upwards of forty-seven feet, succeed each other alternately in regular unbroken order; the next, however, instead of being a mass of vegetable matter, as was due, is a second bed of clay, (28th) and, in the first section, of unequalled thickness; this is followed by a thick bed of sand, the first which had presented itself. Clearly some change must have occurred. A change sudden and short-lived. No sand had previously been deposited, and, on the completion of this bed, the old order of clay and lignite, alternately, is continued for eighteen additional beds; increasing the depth of the deposit by nearly forty feet.

In no instance does the lignite rest on, or support, sand, but always clay.

Though when first dug, the clay is not generally characterized by lamination, exposure to the atmosphere, in most cases, developes this quality.

Fossils were found in only fifteen of the beds, namely, one of clay and four of lignite in the second series, and one of the former and nine of the latter in the third, or lowest. It is only necessary to particularize the following:—

The 7th bed is chiefly remarkable as being, in many instances, a mat composed of the fragments of the coniferous tree *Sequoia Couttsiæ* Heer, and the fern *Pecopteris lignitum.*

The 25th contains a large number of rhizomes of ferns—some of them fully five feet long—and the broken fronds of the ferns *Pecopteris lignitum* and *Lastrea Stiriaca*, Ung., the first being the most prevalent.

The 26th surpasses all the other beds in the number and variety of its fossils. It contains a large number of dicotyledonous leaves, seeds of various kinds, and remains of *Sequoia Couttsiæ;*—branches, twigs covered with leaves, seeds, and fruits sometimes attached to the twigs.

Though most abundant in this bed, the *Sequoia* occurs also in the 7th, 40th, and 63rd; that is in the highest and lowest beds, which have yielded fossils. The Bovey deposit evidently represents but one flora.

The 46th bed yielded a large number of small seed-vessels, which Professor Heer has identified as *Carpolithes nitens.*

Nothing resembling the cone of *Pinus Sylvestris*, described by Dr. Hooker, was found during the exploration.

The so-called "charred" appearance, which the lignite frequently assumes, renders it somewhat difficult to believe that it has not ignited spontaneously; and, indeed, certain

other facts give some countenance to this opinion. Mr. Hatchett, however, who gave much attention to the chemistry of the lignite, was of opinion that there was no evidence of true combustion.*

The lignite is frequently found, in large pieces, as flat as deal boards; in this form the workmen term it "Board coal." It is by no means confined to the lowest beds, but is as characteristic of the fifth, or uppermost, and of that portion of it at which it most nearly approaches the surface, as of any bed in the sections. As pressure must be regarded as essential to this flatness—though probably not its sole cause—it seems impossible to avoid the conclusion, that much of the superior portion of the deposit has been removed by denudation.

The stones so abundant in the "Head," or uppermost division of the pit sections, are sufficient to show that it was formed under conditions dissimilar to those which produced the lower series. Moreover, it lies unconformably over them. No where in the excavation do the lignite and interstratified beds reach the surface; they are cut off, at distances varying from three to seven feet, below it.

The stones vary in size, from blocks upwards of a foot in mean diameter to fragments not larger than hazel nuts. On the "Heathfield," they are fragments of granite, metamorphic rocks, carbonaceous grit, and trap; with a very few of flint and chert. The two last increase in number eastward. In no instance have I found, or heard of limestone debris on the "Heathfield." A transporting current from the north, or north-north-east, seems to be required to meet the facts of the case; that is a transportation nearly at right angles to the direction in which the clays and sands of the true Bovey deposit travelled from Dartmoor; a fact, concurring with those previously mentioned, in favour of a great chronological interval between the "Head" and the deposit it covers.

Nor are we without *organic* evidence of this interval. During the exploration, we found a series of dicotyledonous leaves, nine feet deep in the "Head," about a quarter of a mile east of the "Coal-pit." Professor Heer assigns them to a period much more modern than that represented by the lignite beds, yet to one characterized by a colder climate than Devonshire has at the present day.

It would manifestly be unsafe to conclude that no beds of lignite exist higher than the "5th" in the pit sections.

* "*Trans. Lin. Soc.,*" vol. iv. p. 141; also, "*Phil. Trans,*" *for* 1804, part i. page 396, &c.

Indeed, Mr. Divett found some good beds of coal in a 99 feet shaft sunk 135 fathoms south of the pit; that is in the direction of the *Dip* of the beds. The bottom of the shaft would be six or seven fathoms above the "5th bed" at the pit, on the assumptions that there is no "fault" in the interval and that the *Dip* remains constant. On both these points we have direct confirmatory evidence for the distance of sixty-three fathoms south, as subterranean workings have been carried so far, by "driving down the dip," and show that the beds exist in unbroken continuity and uniform inclination; that is, the beds have been followed to a depth of 80 feet below the bottom of the "Coal-pit."

The 72nd is called the "Last bed," simply because it is the last or lowest worked. That there are still lower beds, is certain, since Mr. Divett "cut two tolerable beds of coal" in a shaft sunk 13 feet below the bottom of the "Coal-pit." Hence, we are now in possession of the following figures:—measured at right angles to the plane of stratification, the "72nd bed" is, at the bottom of the pit, 125 feet below the surface of the plain; it has been followed 80 feet still lower, and lignite has been cut at a depth of 13 feet below it; giving an aggregate of 218 feet, inclusive of the "Head," or fully 35 fathoms for the true Bovey deposit, irrespective of the facts that the bottom has not been reached, and that there is reason to believe that denudation has swept away very much of the superior portion of the formation.

Though no trace of a "fault" exists in the pit, one has been detected a short distance from it. In a 99 feet boring, 126 fathoms east of the pit, a two inch seam of lignite only was cut, instead of the 27 "coal beds"—having an aggregate thickness of nearly 36 feet—passed through, in the same vertical depth, in the pit sections. These are known to exist, in unbroken continuity, along a length of nearly half a mile, at the eastern extremity of which, they suddenly cease, and their place is supplied by a series of clay and sand beds, having the characteristics of the uppermost portion of the second division of the pit sections. There can be no doubt, then, that these facts are evidence of a great "fault;" that the beds on the east of it are an upper portion of the Bovey deposit, preserved—through the intervention of a vertical displacement of at least 100 feet—from the denudation which swept it away on the west, after it had, by its pressure, assisted to flatten the timber in the uppermost stratum of lignite at present existing there; and that this denudation occurred before the deposition of the "Head," since this is

found covering the deposit alike—without material variation in its thickness—on each side of the "fault."

Before the close of the exploration, attention was given to the clay works at Kingsteignton, Aller, and "The Decoy." Lignite exists in each of these localities, but by no means so abundantly as at Bovey "Heathfield." Two small bodies—probably seeds—and one undoubted twig of *Sequoia Couttsiæ*, were found at "The Decoy," but no trace of a fossil was seen elsewhere.

At the suggestion of Dr. Falconer and Sir Charles Lyell, all the Bovey fossils were submitted to the Rev. Dr. Heer, Professor of Botany at Zurich; who determined 50 species of plants and one insect from the true Bovey beds, and 4 species of plants from the overlying "Head." Of the fifty species, twenty-six are new to science, nineteen are previously well-known Miocene forms of continental Europe, and five are of doubtful determination. Following the sub-divisions of the Miocene beds adopted by leading geologists on the continent, it appears that of the previously known species, fourteen occur in the Tongrian or lowest stage, seventeen in the Aquitanian, twelve in the Mayencian, five in the Helvetian, and eight in the Oeningian or highest; that those common to the Aquitanian and other stages are found, in almost all cases, in the greatest number of localities in the former; that of the two not known to occur in the Aquitanian stage, one is apparently confined to the Tongrian below, whilst the other has been met with in this, and also in the Mayencian above (but in only a single locality in each), and may, therefore, be looked for, sooner or later, in the Aquitanian also. Accordingly, the Bovey deposit is considered to belong to this stage of the Lower Miocene.

This decision receives confirmation in the facts, that of the Bovey new species, two have recently been found in continental beds on this horizon, and that the remainder are closely allied to well-known Aquitanian forms. Moreover, so far as they can be identified, the undetermined species are found in this stage also.

Amongst the new forms, the most interesting are the *Sequoia Couttsiæ*, Heer, a conifer closely allied to *S. gigantea* L. (*Wellingtonia*) of California; three remarkable species of fig, the seeds of three new species of *Nyssa*, and two of *Anona*, one new water lily (*Nymphæa*), and many highly ornate *Carpolithes*.

From the characters of the lignite as well as of the fossils, Professor Heer concludes that, during the Lower Miocene

period, the Bovey basin was occupied by an inland fresh water lake, of considerable depth, into which tree-stems—probably belonging, in great measure, to the *Sequoia*—and other vegetable debris were floated, not only from the circuit of the immediate hills, but, doubtless, from greater distances.

The four species found in the "Head," are three of *Salix*, and one of *Betula* (*B. nana* L.); the last is a dwarf arctic plant, having at present no British habitat south of Scotland, and occurring in mid-Europe only on mountains and sub-Alpine peat mosses.

If to the 35 fathoms, mentioned in an earlier page, the figures obtained from the "fault" be added, a depth of upwards of 50 fathoms is arrived at for this ancient Miocene Devonshire lake; indeed, the clay workers assert that their borings sometimes amount to quite this estimate.

The period represented by the Bovey beds must have been of considerable duration. So far as the strata themselves show, it was, in the district under consideration, one of great tranquillity. A long series of beds, alternately vegetable matter and fine clay, succeed each other in scarcely interrupted order; the three intruded arenaceous layers probably mark nothing more than a somewhat increased velocity in the current or river which conveyed the detritus of the granite hills of Dartmoor into the area of deposition; but which, instead of being permanent, was as short lived as it was unusual.

The late investigations at Bovey, then, have been so far successful, that they have settled the vexed question of the age of the deposit occurring there—added 49 new species to the fossil flora of this country, of which, 26 are new to science—recognized the first traces of animal life which the deposit has yielded—detected another British fragment of the Miocene page of the earth's history, which, until 1857, was supposed to be totally unrepresented in England—taken us back to a remote period, when the slopes of Devonshire were clothed with a luxuriant sub-tropical vegetation—separated, by a wide chronological hiatus, the lignite and associated beds from the gravels overlying them; a hiatus evidenced by the dissimilarity and unconformability of the two series; by a change in the direction by which detrital matter reached the Bovey area; by great vertical displacements of the lower series, followed by the denudation of the consequent surface-inequalities, prior to the deposition of the upper; and by the exchange of an extinct flora, requiring a high temperature,

for an existing one, which is now confined to Arctic and Alpine regions.

Remote, however, as was the earliest of the two periods thus represented, the great leading geographical features of the district were pretty much as at present. The Teign and Bovey rivers were then in existence, but, instead of the latter being tributary to the former, their mouths were three miles apart, and both fell into the same deep, sluggish, fresh-water lake, which occupied the site of the present Bovey plain, and was guarded by Dartmoor and the other hills which still constitute the prominent characteristics of the district.

ON

"THE RELATIONS TO LITERATURE OF A PROVINCIAL ASSOCIATION FOR THE ADVANCEMENT OF LITERATURE, SCIENCE, AND ART."

By the Rev. J. Erskine Risk.

The Devonshire Association now inaugurated, while professing to a certain extent to follow in the wake of the British Association, takes Literature and Art under its cognisance as well as Science. It does not demand much reflection to come to the conclusion that the step was an indispensable one, to give the necessary stability and vitality to a provincial association. After alluding to the formation of the society, he proceeds: How may our Association best promote the cause of literature in the province? We propose to make our meetings annual; and, therefore, it is obvious that the papers presented must, to be worth anything, embody the results of the thought and reflection of the past year on the various forms of literary activity which have specially attracted the writers of the several papers. Thus, one may feel it more congenial to his taste to register and chronicle the progress, or otherwise, of poetry during the year. He may take in the whole range of the national poetry, or else may find much to remark upon in the local efforts of the province. And surely in a county abounding so much in natural beauties as our own, it might reasonably be thought that a supply of poets would always be at hand; as it is well known that there is no lack of artists, with hearts which beat in intimate sympathy with the varied attractions of their native soil. It is not for me just now to show how fully such anticipations have been realised. Satisfied with pointing out the field of labour, I leave it to other labourers,

or other occasions, to enter upon it. I am well assured that a yearly chronicle and critique of the year's national or local poetry, which would be then still fresh in men's memories, would re-act most favourably alike on the minds of the discussers of its merits, and the mind of the author himself, if it should be his lot to become acquainted with a well-conducted discussion of the kind in our yearly transactions. The blending of the spoken, with the written critique, would thus impart a flavour of reality to the whole, which a written criticism alone, without the oral commentary, could not be expected to possess. And if such would be the result with regard to poetry, where only a limited number can be supposed to be endowed with the necessary taste and discrimination to give their opinion any weight, what may we not look for in the reviews and criticisms which may annually come out at our tribunes of the historical performances of the year? It is not every year that a Macaulay writes, or a Froude elaborates his paradoxical re-adjustments of old historical facts. We cannot every year have our fancies tickled by the assiduous essays of a Buckle, to prove, in all seriousness, that the movements of mankind are as inexorably governed by the narrow limits of a table of statistics, as those of an automaton are controlled by the workings of the internal machinery, which gives it the temporary appearance it presents of spasmodic life. No! a style like Macaulay's, if we are ever to see the like again, can never more flow from the pen which death has rendered powerless, of the great master who gave it all its life and beauty; while Buckle's laborious statistics, which seem so likely to receive many additions from the large collections of MSS. he has left behind him, can never again, perhaps, be taken up with the same unfaltering zeal which animated him who breathed out his life near Damascus, among the Arabs of the desert, in the endeavour to add to his already vast accumulations of unsuspected lore. The minds which reflect their own personality on the great facts of the past, must be as changing as the lights which they reflect, but there never can be any lack of history for the busy workers of this Association. The very age in which we live is history itself, in a sense, in which no preceding age has ever been. Caught up and chronicled by the telegraph, and wafted on the wings of the press, there are but few actions of any note which can now-a-days escape becoming historical. Nor is this all; the rapidity with which the tidings fly is such, that the voice of nations pronounces its award long before the solitary student

can in laboured periods pronounce the approbation or the censure which he thus hands down to posterity. Be it ours, then, to watch the award of peoples; and in the critiques which may be read or spoken before us yearly, let us seek to confirm or to modify the judgments of the hour, as the sentence of calm reflection, unbiassed by prejudice or indecent haste, would lead us to decide. Nor do I wish to pass by what I may term the literature of science without some comment. I believe, that as the technical formula of science becomes more fruitful of results, the more it is simplified in statement, and so extended in application; just so is the literary style, in which scientific results are made patent to what I may term "the lay mind," capable of very considerable improvement. The day which beholds a more general adaptation of every day language to those phenomena of science, which, however, are not discovered every day, will, I believe, also witness a more general devotion of public attention to investigations which grow in interest as they grow in familiarity. We cannot forget that a movement in favour of the general cultivation of science, more especially natural science, has everywhere set in. Science can no longer be considered the especial property of the professional or so-called scientific man. The great work of naturalisation has commenced. The old attempts to incrust the works of nature, fossils and all, with a fossil-like nomenclature, inartistically compounded from the dead tongues, have proved, what I must be pardoned for terming, at least, in a literary point of view, a dead failure. The time cannot be far distant when the barbarous quasi-classical names by which chemists, botanists, and others, thought they explained everything by simply "naming their tools," will be consigned to the tomb of all the Capulets, with the defunct "rypophagon" of the barber, and the "bostrukizon" of the hairdresser. Everything which brings the terms of science to rival the simplicity of the works of nature, will, I am sure, admit the student nearer to the discovery of nature's secrets. In this way may literature be the handmaid of science as well as the revealer of many a secret of her own. Poetry, history, antiquarian lore, criticism, nay, style itself, by the use of a stricter method, and a more natural development, will thus effect much towards a return to unpretending simplicity. An association with aims like ours, may contribute much to this result.

BOVISAND SAND-BEDS.

By Spence Bate, Esq., F.R.S., F.L.S., &c.

During the time while the excavations were being made in the neighbourhood of Plymouth, in connection with the erection of fortifications, a considerable quantity of sand, far above high water mark, was exposed at Bovisand. This sand consists of two beds, separated from each other by a portion of the cliff which forms a salient point directed westward towards the Breakwater.

The first bed, or that which is most seaward, is formed of a mass of sand that is about 28 feet deep,* diminishing upon either side until it attains a depth of only 8 ft. 6 ins., from which it gradually lessens until it disappears near a point or spur of rock running out from the hill behind, on the south side, towards the sea.

The deposit of sand is covered with about 12 or 14 feet of debris, formed of clay mixed with stones and fragments of rock, such as that on which the sand rests; these fragments are very slightly rolled or water worn.

Throughout the bed are found numerous thin veins or layers (not always horizontal) of fine sand of a bright red colour, with small fragments of slate interspersed; these veins are from one-sixteenth of an inch to two inches and upwards in thickness.

At all the points where observation has been made, the bed is composed of two distinct layers viz., coarse sand at the bottom, and fine sand at the top, the two being usually divided by a stratum of stones and fragments of rock, set in with sand of a coarser character. This band or stratum varies in depth; but at the point measured it is about 12 inches, while the sand below is 2 ft. 6 ins., and that above it is 4 ft. 6 ins.

The lowest point of the bed, where it rests upon the solid rock, is 27 feet above the mean level of the sea, while its

* I am indebted to my friend, Capt. Moggridge, R.E., for the measurements, as well as for specimens of the sand, which are deposited in the Museum of the Plymouth Institution.

distance from the present high water mark, measured in a straight line to the nearest point, is 95 feet.

The second bed stands in an old ravine, and, while it is less extensive in horizontal length, reaches to a greater vertical height, that is, 123 feet above the mean level of the sea, and 155 feet in a straight line from the present high water mark.

There are here two veins exposed in the excavations, the upper consisting of fine sand, about six feet in thickness; the lower about three feet, there being an interval between them of five feet, consisting of shaly gravel, fragments of rock, stones, &c.

The dip of this bed near the centre or axis of the ravine is 38° towards the west, both strata being parallel with each other.

The depth to which the beds extend has not been ascertained, no excavation as yet having been made deep enough; but they probably terminate at about 20 feet above the mean level of the sea, where they would come into contact with the rock.

In endeavouring to account for any natural phenomenon that is difficult of explanation, it is legitimate to accept such evidences as come within the bounds of reasonable probability.

That such a mass of sand as is here spoken of should be found resting upon the face of the bare rock, and bound under detrital material to the depth of many feet, is in itself an object of considerable curiosity, and difficult of explanation.

Sand can only be accepted as being the detrital evidence of the former action of water, although it by no means follows that the power that broke the submerged matter into sand existed where the sand may be found. The particles of which the sand is composed being very minute, are taken up and frequently carried to a considerable distance from the place of its formation. Evidences of this exist in great abundance in the county of Cornwall, where large tracts of land at Penryn are covered by blown sand.

It appears to me that there are three ways only by which the presence of this sand-bed at Bovisand can be accounted for.

It is either the result of a fresh water stream, a marine deposit, or the accumulation of sand drifted by the action of the wind.

In regard to the first, there is little probability of there ever having been any river that could have passed over the

spot where the sand rests, since on one side lies the Staddon Heights, whilst on the other is the broad Atlantic.*

That it is a marine deposit appears more probable; but there are one or two points which suggest the idea, that although of marine origin, it does not exist where it was first deposited. These points are—First, that we have not been able to trace the slightest evidence of any object known to be marine in any part of it; and, second, that the dip of the stratification of some of the beds is at too great an angle for the sand to have been deposited in water in the position in which it now rests.

The last, and we are inclined to think true solution is, that it is a bed of sand blown from a previously existing beach, which, when the tide retired, soon dried in the summer sun, and was then carried to a distance inland, and which alterations in the configuration of the coast line have not displaced.

It may appear to some, that the mention of a previously existing beach, from which the sand was brought by the winds, is very like a creation for the purpose; but we think that it is one that it is not beyond the bounds of legitimate hypothesis, since in the same neighbourhood, viz., in Plymouth, there still exists the remains of an antient beach that must have been formed by the sea when the land held a very different altitude in relation to the sea than it at present does.

It may suggest itself to some, that should the beach from which we suppose that the blown sand may have come, have been formed at the same period as the raised beach at the Hoe, that it would, like it, have been still in existence in its position. It is, however, quite evident, that a large portion of the original coast line has been broken down and borne away by the wearing influence of atmospheric phenomena, and with it, no doubt, most of the traces along the coast of the antient sea level; and it appears to me, that it would be a very desirable object for the members of this Association, if they were to commence their scientific existence by reporting from time to time all the evidences of antient sea beaches that still remain in this county. It would be, not only a work of great value in a scientific point of view, but one the evidences of which are gradually perishing, and every year depreciates; it is desirable therefore, if possible, that such observations should not be long deferred.

* Since this paper was read, the discovery of fresh water sand on the Hoe must considerably modify the opinion here given.

ON THE FERNS OF SOUTH AFRICA,

AND A COMPARISON OF THEM WITH THE ACROGENOUS PLANTS OF GREAT BRITAIN AND NORTH AMERICA.

BY W. S. M. D'URBAN.

[*Abstract.*]

DURING a twelvemonths' residence in South Africa, principally in the Province of British Kaffraria, on the eastern frontier of the Cape Colony, I paid much attention to the Ferns of that region, investigating the laws which govern the distribution of the species there.

According to the present state of my knowledge, there are 47 genera and 143 species of Ferns and their allies in Southern Africa, including, in that term, all the country lying south of the great Orange River, which, with its affluent the Vaal, almost completely traverses the continent, flowing from east to west, and emptying itself into the Atlantic Ocean in lat. 28° 30′ south. This, the largest river south of the Tropic of Capricorn, forms the northern boundary of the British Colonies, and marks the limits of the peculiar Cape Flora. It is worthy of note, that not one single genus of Ferns has yet been discovered peculiar to this country, and probably not two-thirds of the species can claim that distinction.

A considerably larger number of species are to be met with in the Eastern districts and Natal, than in the Western parts of the Cape Colony, and far more in those districts which border on the coast, than in those inland. In the extreme Western part, including Little Namaqualand, 65 species have been recorded. In the Eastern districts and British Kaffraria, the number rises to about 75, whilst in Natal 93 species are now known, though its dense primeval forests have been but partially explored. In accounting for the distribution of species, many disturbing causes have to be considered. In Southern Africa, where there exists great diversity of elevation of the land above the sea, there is

necessarily every variety of climate, and great difference of temperature between localities under the same parallel of latitude. The Eastern districts, as a general rule, are far better supplied with rain than the Western, and the greater abundance of forest, resulting from the increase of moisture, as we proceed eastward from the Cape, vastly influences the relative frequency of Ferns, not only in species, but also in individuals. It is to the South East winds which prevail during spring, summer, and part of autumn, that the Eastern Province is indebted for its supply of rain. These winds arrive on the east coast laden with clouds from the Antarctic Ocean, and striking against the mountain ranges, running parallel to the coast, and at no great distance from it, are deprived of their moisture, and, consequently, on the inland side of the mountains they are perfectly dry, and instead of depositing moisture, absorb what already exists in the soil. Thus, for the largest portion of the year, the interior and western districts are without rain. In the winter season, however, the N.W. monsoons blow, and during their prevalence the same thing takes place in exactly the opposite direction; so that in the west the winter is the wet season, whilst in the east it is the dry, and *vice versâ;* but as the period during which the S.E. winds prevail is so much longer than their cessation, it is plain why the Eastern and coast districts receive more rain than the Western and inland ones.

It has long been noticed that there is a marked difference in the character of the Phanerogamic plants east and west of the great Fish River, and this is accompanied by a total change of geological formation, the greater part of the country to the west of that river, being occupied by the Devonian slates and quartzites, whilst on the east of it the whole country lies on shales and sandstones of Permian or Triassic age, intersected in all directions by greenstone dykes. My investigations, however, do not lead me to suppose that the geological character of these districts has much influence on the distribution of the Filices, whatever it may have upon that of the Phanerogamia.

Although the number of South African Ferns appears considerable, yet, if we compare it with that of the rest of the Flora, we shall find that the proportion which the Ferns bear to the Flowering-plants is but small. Dr. Pappé, the colonial botanist, thinks that his estimate of 12,000 species for the whole South African Flora is but a moderate calculation. If we deduct 1,000 species from it for the Cryptogamic forms,

and divide the remainder by the number of the Ferns (143), we get nearly 77 as the quotient, which is a smaller proportion even than that given by Humboldt, in his "Views of Nature," for the dry parts of southern Italy, namely $\frac{1}{74}$.

One of the greatest obstacles to arriving at any satisfactory conclusion in these investigations, is the difficulty of deciding what ought to be considered a species, and what constitutes a variety. Dr. Pappé, in his "*Synopsis Filicum Africæ Australis,*" enumerates 54 genera, and 161 species of Ferns and Lycopodiaceæ; but following the views of Sir William Hooker, and rejecting many spurious species, I have reduced this number to 143 species, contained in 47 genera, even after adding in several species, discovered by myself and friends, either altogether new to science, or not described by Dr. Pappé. Of course, in such an immense tract of country as Southern Africa, a very large portion of which is still almost unknown to the botanist and scientific traveller, there must be a considerable number of species yet undiscovered; and though Thunberg, Ecklon, Zeyher, Drége, Gueinzius, Plant, and others, made rich collections in various parts of South Africa, yet they left many large districts unexplored. It is not likely, however, that many novelties amongst the Ferns will ever occur in the desert plains of the interior, called "Karroos," and the Pteridogolist will probably reap the richest harvest of new species in the dense aboriginal forests, which cling to the southern slopes of the mountain ranges of the coast districts.

It will be instructive to compare the Acrogenous plants of South Africa, with those of Great Britain and North America, regions which present the greatest possible contrast to it, as well as to each other, not only in climate, but also in physical geography. Firstly, let us take the British Isles, with their moist climate and in general moderate temperature. Secondly, that vast continent, North America, abounding in great rivers, lakes, and forests, and a temperatnre oscillating between the fierce heat of its summers, and the arctic rigour of its winters. Lastly, South Africa, whose annual mean temperature is higher than that of the two former, and its climate more equable, but is subject to frequent droughts of long duration, and as a consequence possesses few rivers of any importance, none indeed, being capable of navigation.

Assuming that a moist and moderate climate is the most favourable to the production and growth of Ferns and their allies, we are prepared to find the relative frequency of species to be greatest in Great Britain, and investigation

will prove it to be so. Taking the number of the Flowering-plants, as given by Bentham, in his "Handbook of the British Flora," as the nearest the truth; viz., 1232; and 53 as the number of the Acrogens, we have the proportion for the latter to the former of nearly $\frac{1}{23}$.

Professor Asa Gray, in the second edition of his "Manual of the Botany of the Northern and Midland States of America," includes the greater part of Canada, and all the States east of the Mississippi and north of Tennessee. He gives 2091 species as the total of the Phanerogamic plants found within this area, and 76 as the number of the Acrogens. This yields the proportion for the latter of about $\frac{1}{27}$. As before stated, that for South Africa is $\frac{1}{77}$. Great Britain, therefore, notwithstanding her limited area, is comparatively the richest in Ferns and their allies.

In Great Britain and North America, a considerable portion of the Acrogens are not true Ferns, but belong to the *Equisetaceæ* and *Hydropterides*, and many grow in water; whereas, I know of but one aquatic species in South Africa, namely, the curious *marsilca quadrifolia*, also a native of Australia which I observed covering the surface of the brackish streams of the Fish River Bush, with its brilliant green fronds: and the genera *Equisetum*, *Isoetes*, *Pilularia*, and *Azolla*, as far as I am aware, are not represented in that country.

I find that 16 genera and 29 species of Ferns and their allies are common to Great Britain and North America; 17 genera and 16 species are found both in Great Britain and South Africa; 13 genera and 14 species occur both in North America and South Africa, whilst 12 genera and 10 species are common to all three.

ON THE AGE OF THE DARTMOOR GRANITES.

By W. Pengelly, Esq., F.G.S.

Though our science has risen above the stage from which she taught that all granites are parts of the original crust of the earth; though she has advanced so far as to doubt whether, in all cases, the granitic was the first phase of rock-existence which the materials composing it assumed, and to

entertain the question whether such rocks may not be the extreme form of metamorphism, which has obliterated all traces of an earlier condition; and though she may prudently decline to point out, in the large circle of her rocky acquaintances, one mass of crystalline unstratified rock which, as such, can be proved to be older than some known beds of mechanical origin; it remains to be the rule, rather than the exception, to meet with persons, frequently well informed and not without an interest in geology, who still cling to the notion, or allow it to cling to them, that every mass of granite is a *primitive* rock, in the strict chronological import of the term, and represents a period in the earth's history prior to the possible existence of sedimentary strata, or of organized beings. Indeed, the opinion that granite is, in all cases, a *primary* rock has so large a place in the public mind, that one might prudently hesitate before throwing such a question as "What is the age of the Dartmoor Granite?" before an audience having a very large admixture of the popular element.

It has long been known that the age of the granitic rocks of Dartmoor can be safely limited on the side of antiquity. Sir Henry De la Beeche,* Professor Sedgwick, and Sir R. I. Murchison,† Mr. Godwin-Austen,‡ and Mr. Ormerod,‖ have called attention to the fact that the granites have sent veins into the culmiferous strata of North and Central Devon, and that the latter are much bent and contorted, probably by the intrusion of the former. There can be no doubt, then, that the granites are more modern than the culm series.

It is well known that the Dartmoor region contains three well-marked varieties of granitic rocks; namely:—*schorlaceous*, *porphyritic*, and *elvan*. Now, according to Mr. Godwin-Austen, these are not only of *three distinct ages*, but the first had already become *compact and jointed* before the second had intruded itself amongst it; and, in like manner, the protrusion of the last was posterior to the *consolidation* of the second, which it traverses. The same author shows that the *oldest*—the schorlaceous—variety is *more modern* than the culmiferous beds.§

Our next business is to find, if possible, a *modern* limit to the age of the granites.

* "Report on the Geology of Cornwall, Devon, &c." p. 165.
† "Geol. Trans." 2nd Series, vol. v. part iii. pp. 686-7.
‡ "Geol. Trans." 2nd Series, vol. vi. part ii. p. 477.
‖ "Quart. Journ. Geol. Soc." vol. xv. p. 492.
§ "Geol. Trans." 2nd Series, vol. vi. part ii. p. 477.

Amongst the *stratified* rocks of the county, the red conglomerates and sandstones, which give such a character to the soil and cliffs of the south-east of Devon, succeed, in ascending order, the culmiferous beds already spoken of; they are the next more modern. Now conglomerates may be regarded as natural museums, in which we are likely to find specimens of all pre-existing rocks occurring in their neighbourhood; and the fact that any rock existing in a given locality has no representative fragment in an adjacent conglomerate, though merely negative evidence, would not be a bad, though by no means an unimpeachable, basis on which to found the opinion that such rock is more modern than the conglomerate thus destitute of any indication of its existence. Such an opinion, however, would, of course, be overthrown by the first fragment which further research might bring to light.

Sir H. De la Beeche states that he had been unable to discover any portion of the granite amongst the materials of the red conglomerate extending from Torbay to Exeter, and speaks very doubtingly of certain "pebbles like some varieties of Dartmoor Granite" which he detected in the conglomerate at North Tawton and Sampford Courtney.* Mr. Godwin-Austen, who has given much time and attention to this question, states that no granite pebbles have been found among the red conglomerate materials, and adds that they are not met with below the supracretaceous superficial accumulations which cap the Haldons. He thinks it possible "that the rise of the Dartmoor granite, in its present form, may belong to a period comparatively recent."†

Happening a few years ago to be at North Tawton, I mentioned the subject to Mr. William Vicary, then resident there. He immediately took me to the conglomerate, and, in a few minutes, extracted two or three pebbles, which we both regarded as certainly of Dartmoor derivation. I am not sure that either of us would have contended that they were true granite, if by that term we are to understand a mass made up solely of distinct crystals of felspar, quartz, and mica; nor, thus defined, would any one be prepared to call every thing granite which occurs in the true Dartmoor country. Sir H. De la Beeche has given a comprehensive, but not by any means exhaustive description of the various granitoid combinations which are met with in the Dartmoor district.‡ Not unfrequently nodules, apparently segregative, which,

* "Report on the Geology of Cornwall, Devon, &c.," p. 166.
† "Geol. Trans." 2nd Series, vol. vi. part ii. p. 478.
‡ "Report on the Geology of Cornwall, Devon, &c.," p. 157.

found elsewhere, might be mistaken for sandstone, occur in the substance of the ordinary granite.

Again, the observer who enters a Dartmoor quarry soon discovers that granite is by no means weather-proof; the effect of the weather is very discernible fully a foot or more within the exposed surfaces; a more or less dark or ferruginous-looking band, of about the width just mentioned, graduates into the unchanged rock, and suggests that small fragments might, through long exposure and rough usage, undergo a very considerable change of aspect.

The boulders which occur so abundantly in the beds of the Dartmoor rivers and rivulets are found to be more or less changed in character; were it not that every gradation can be readily supplied, it would be sometimes, at least, a little puzzling to recognize a member of the Dartmoor family of rocks in the fragments met with along the river-courses. It is these travelled masses which must tell us whether the red conglomerates of Devonshire contain specimens derived from the central upland of the county; and I have no hesitation in believing that every one approaching the subject in this way, would pronounce the North Tawton pebbles to be of Dartmoor origin.

In August, 1861, I met Mr. Vicary at Exeter—where he now resides—and again introduced the subject of the North Tawton pebbles; on which he informed me that he had recently found unmistakable Dartmoor fragments in the red conglomerate of Great Haldon; and also that the fact of *granite* pebbles occurring there, was mentioned in Brice's "History of Exeter."*

A discovery of so much interest was not to be neglected; accordingly we took an early opportunity of visiting Haldon. Passing through Alphington and Kennford, and leaving the great road from Exeter to Plymouth, by Chudleigh and Ashburton on the right, for that which takes a more easterly direction to Newton-Bushel, we reached our ground about five miles and a half from Exeter; and Mr. Vicary at once pointed out one or two well marked fragments of the true Dartmoor series of rocks in the conglomerate, but so far decomposed and disintegrated that it was impossible to extract them in their integrity; a further search was soon rewarded with several less perishable specimens, amongst them representatives of each of the *three* kinds of granite recognized by Mr. Godwin-Austen in the Dartmoor country.

* "History of Exeter," by Thomas Brice, 1802, p. 114.

That part of Haldon at which the pebbles were found is about five miles, in a straight line, from the nearest point of the granite. The red conglomerate at Newton-Bushel and several other places, approaches to within the same distance from the granite: the fact, if it be one, that no such pebbles have been found in these localities, should stimulate to further and careful search; and if, after all, they really do not exist there, it need not be a matter of very great surprise; changes in the physical geography of the district, amply sufficient to account for it, may have occurred since the period of the red conglomerate. If it be true that granite pebbles occur at Sampford Courtney, North Tawton, and Haldon, but do not exist on the southern coast of the county,—in other words, on the north and north-east, but not on the east, of Dartmoor,—may we not have in this fact an indication of the prevailing direction of the most powerful currents, or other agents of transportation, in this part of modern Devonshire during the Red Sandstone era?

But to return. The facts now in our possession appear to compel the belief that the Dartmoor granites were not in existence when the culmiferous rocks of north and central Devon were deposited, but did exist and were exposed at the surface in the red conglomerate era. In relation, then, to the stratified rocks of the county, we have both an *ancient* and a *modern* chronological limit for the granites. Our next question is, "What are the places of the limiting rocks in the chronological series of the geologist?"

There is no difficulty as to the answer respecting the *ancient* limit—the culmiferous beds. Professor Sedgwick and Sir R. I. Murchison state, that the "upper division of the culm series contains fossils identical with those in the upper division of the coal measures;"* they are, therefore, the geological equivalents of the ordinary British coal fields, and represent the close of the "*Carboniferous Period.*"

It is not so easy to settle the *modern* limit—the red sandstones and conglomerates. That they belong somewhere between the Carboniferous and Jurassic systems there can be no doubt, since they overlie the Culmiferous beds and pass under the Lias; but whether they are Triassic or Permian has not been considered so certain as could be desired. They are entirely destitute of fossils, excepting those only which occur in the calcareous pebbles, which, of course, belong to the age of the parent limestone. The sandstones are evidently of *littoral* origin; their surfaces frequently display *wave*-ripple

* "Geol. Trans.," 2nd Series, vol. v. part iii. p. 687.

marks, desiccation cracks, and impressions of rain-drops; but no foot-prints or other organic traces have ever been detected on them; they apparently contain no palæontological evidence whatever of their age.

More than one eminent geologist has been struck with the angular character of the fragments composing the so-called conglomerate, and has remarked that, in its physical character and general appearance, the formation is rather Permian than Triassic. I am not without hope, that the granite pebbles, so frequently mentioned, may help to settle this question, by showing that the red rocks are Triassic.

Whatever may be our opinion respecting the origin of granite, we are probably agreed that it was formed in Plutonic depths, requiring enormous pressure for its elaboration, and, therefore, at least, commensurate resistance in a superincumbent crust.

Mr. Sorby estimates the pressure under which the St. Austell granite was formed as equivalent to that of 32,400 feet of rock, that of the mean of the Cornish granite at 50,000 feet, and that of Ding Dong Mine, near Penzance, at 63,000 feet.* He gives no estimate for Dartmoor, but taking his *lowest* figures, we have a pressure equivalent to that of a pile of rocks six miles in thickness; but since the pressure was probably due to the expanding power of some agency acting within or beneath the granitized mass, requiring resistance and not pressure, strength and not weight in the overlying crust—we will content ourselves with a small fraction of this: nevertheless there must have been a solid crust of vast thickness for denudation to strip off before a granite pebble could have travelled to Haldon. Even if we suppose that some paroxysm uplifted the granite in a solid state, so as to shiver the overlying masses, and thereby facilitate the work of denudation, still the removal of such a mass of rock must have required an amount of time so vast that it seems totally impossible to regard the red conglomerates and sandstones as more ancient than the lower Trias.

The supposition, however, that the granite was thus thrust through the overlying rocks is altogether improbable, for the latter appear to have shared in all the great movements which the former may have undergone, since the granite veins, taken in general, *are mere prolongations of the central granite, inseparable from it*, and contemporaneous with it.†

* Sedgwick and Murchison in "Geol. Trans.," 2nd Series, vol. v. part iii. p. 686.

† "Quarterly Journal, Geological Society," vol. xiv. p. 493.

The time of denudation, moreover, vast as it probably was, formed but a fraction of the period separating the culmiferous and red rocks. At the close of the Carbonifeous period there was no Dartmoor granite; after this we have the formation of three distinct masses of granitoid rocks, very distinguishable from one another, clearly results of dissimilar conditions within the same area, and referable to different and probably widely separated times; but all this was anterior to the commencement of the conglomerate era, since pebbles of each kind of granite occur in the Haldon beds, which belong to the *base* of the red rocks of Devonshire.

Should it be objected that the granites, though requiring great pressure, were not necessarily formed beneath an accumulation of *rocky* matter, but possibly under an equivalent depth of sea, it does not appear that this can greatly affect the question, at least by way of abridgment.

Take what view of the case we may, an enormous period between the culm and conglomerate series appears inevitable; a period during which great changes were effected within, and on, the crust of the earth—changes which, from their nature, could not have been contemporary, but must have followed each other in a definite and ascertained order, and, at least, the greatest part of which convulsion or catastrophe must have been powerless to produce or hasten.

Unless we assume that a great chronological interval elapsed between the Carboniferous and Permian periods—and to this Palæontology appears to give no sanction—the facts of the case before us seem to require the belief:

1st. That the granites of Dartmoor are not older, at most than the close of the Carboniferous period.

2nd. That they had been stripped bare by denudation when the materials of the red conglomerate were being brought together.

3rd. That the red conglomerate and sandstones are not of higher antiquity than the Lower Trias.

4th. That the Permian period was of great duration.

W. Brendon, Printer, [illegible], George Street, Plymouth.

REPORT

OF

THE SECOND MEETING

OF THE

DEVONSHIRE ASSOCIATION

FOR

THE ADVANCEMENT OF SCIENCE, LITERATURE, AND ART,

HELD AT PLYMOUTH, JULY, 1863.

LONDON:
TAYLOR & FRANCIS, RED LION COURT, FLEET STREET.
PLYMOUTH: W. BRENDON, GEORGE STREET.
1864.

OFFICERS.

1863–64.

President:

C. SPENCE BATE, Esq., F.R.S., F.L.S., &c. &c.

Vice-Presidents:

W. DERRY, Esq., *The Worshipful the Mayor of Plymouth.*
J. L. COLLEY, Esq., *President of the Plymouth Institution.*
SIR JOHN BOWRING, LL.D., F.R.S., &c.
SIR W. SNOW HARRIS, F.R.S.

Hon. Treasurer:

W. VICARY, Esq., F.G.S.

Hon. Local Treasurer:

J. DABB, Esq.

Hon. Secretaries:

REV. W. HARPLEY, M.A., F.C.P.S.
H. S. ELLIS, Esq., F.R.A.S.

Hon. Local Secretary:

J. B. ROWE, Esq., F.L.S.

Council:

T. F. BARHAM, Esq.
REV. R. H. BARNES, M.A.
W. S. M. D'URBAN, Esq.
JAS. DABB, Esq.
W. H. GAMLEN, Esq.
J. N. HEARDER, Esq.
W. F. MOORE, Esq.
G. W. ORMEROD, Esq., M.A., F.G.S.
REV. J. ERSKINE RISK, M.A.
J. B. ROWE, Esq., F.L.S.
W. R. SCOTT, Esq., PH.D.
R. STEWART, Esq., M.R.C.S.

LIST OF MEMBERS.

Abraham, R. T., *Heavitree, near Exeter.*
Appleton, Edward, F.I.B.A., *Cotswold, Torquay.*
Balkwill, Alfred, *Plymouth.*
Balkwill, Fred., *Plymouth.*
Barham, T. F., M.D., *Highweek, Newton Abbot.*
Barnes, Rev. R. H., M.A., *Marychurch, Torquay.*
Bastard, S. S., *Summerland Place, Exeter.*
Bate, C. Spence, F.R.S., F.L.S., &c., *Plymouth.*
Berry, Richard, *Chagford.*
Bowring, Sir John, LL.D., F.R.S., &c., *Claremount House, Exeter.*
Brent, R., M.D., *Woodbury.*
Cann, Wm., *West of England Insurance Office, Exeter.*
Cole, Robt., F.S.A., 54, *Clarendon Road, Notting Hill, London.*
Colley, J., *Plymouth.*
Cresswell, C. H., *Heavitree.*
Dabb, Jas., *Plymouth.*
Dansey, Geo., M.D., *Stoke, Plymouth.*
Derry, W., *Houndiscombe House, Plymouth.*
Divett, John, *President of the Teign Naturalists' Field Club, Bovey Tracey.*
D'Urban, Major-Gen., *Newport, Exeter.*
D'Urban, W. S. M., *Newport, Exeter.*
Dymond, Robt., Jun., *Friars, Exeter.*
Elliot, W. H., M.D., *Bowverie House, St. Leonard, Exeter.*
Ellis, Henry S., F.R.A.S., 1, *Fair Park, Exeter.*
Follet, John, *Mount Weir, Exeter.*
Fook, J. V., *Plymouth.*
Fox, S. B., *Southernhay, Exeter.*
Gamlen, W. H., *Tiverton.*
Gendall, John, *The Close, Exeter.*
Glanville, S., *Bouverie Place, St. Leonard, Exeter.*
Hamilton, A. H. A., *Millbrooke, near Exeter.*
Harpley, Rev. W., M.A., F.C.P.S., *Plymouth.*
Harris, Sir W. Snow, F.R.S., &c., *Plymouth.*
Hayward, John, *The Close, Exeter.*
Hearder, G. E., *Torquay.*
Hearder, J. N., *Plymouth.*
Hedgeland, R. W., M.A., *St. Leonard, Exeter.*
Hine, J. E., C.E., *Plymouth.*
Horne, F. B., M.R.C.S., *Torquay.*
Ingle, Rev. J., M.A., *Mount Radford House, near Exeter.*
Jeffery, E., *Dix's Field, Exeter.*
Jones, Winslow, *St. Leyes, Heavitree.*
Kendall, W., J.P., *Summerland Place, Exeter.*
Littleton, T., M.D., *Saltash.*
Mardon, Rev. B., M.A., *Sidmouth.*
Miles, W., *Dix's Field, Exeter.*
Moore, W. F., *The Friary, Plymouth.*
Ormerod, G. W., M.A., F.G.S., *Chagford.*
Owen, Col., R.E., *Leigham Terrace, Plymouth.*
Palk, Sir Lawrence, M.P., *Haldon House.*
Parfitt, Edward, *Devon and Exeter Institution, Exeter.*
Peacock, Geo., *Starcross.*
Pengelly, W., F.R.S., F.G.S., &c., *Torquay.*
Pollard, W., Jun., M.R.C.S., *Torquay.*
Pycroft, A., *Kenton.*
Ridgway, C., PH.D., *Marlborough House, Exeter.*
Risk, Rev. J. E., M.A., *Plymouth.*
Reading, J. J., M.R.S., *Plymouth.*
Richardson, J., *Plymouth.*
Rogers, W., *Countess Weir, near Exeter.*
Rooker, A., *Plymouth.*
Roper, C. H., M.R.C.S., *Magdalen Street, Exeter.*
Rowe, J. Brooking, F.L.S., *Plymouth.*
Scott, W. R., PH.D., *St. Leonard, Exeter.*
Sercombe, Rupert, *Fairfield, Exeter.*
Shapter, T., M.D., *Barnfield, Exeter.*
Shepphbard, A. B., *Torquay.*
Shute, R., *Baring Crescent, Exeter.*
Stewart, R., M.R.C.S., *Torquay.*
Stewart, C., M.R.C.S., *Plymouth.*
Teesdale, C. L., *Swiss Cottage, Exeter.*
Templeton, J., M.A., F.G.S., *Exeter.*
Thomas, J. L., *Exeter.*
Tracey, Rev. Eugene F., M.A., *Ford Park, Plymouth.*
Turner, T., *Manston Terrace, Heavitree.*
Vicary, W., F.G.S., 7, *Albert Terrace, St. Leonard, Exeter.*
Vivian, E., M.A., &c., *Torquay.*
Walker, F., 4, *Queen Street Road, Exeter.*
Widger, W., *Torquay.*

Life Member.

Lyte, F. Maxwell.

THE REPORT OF THE COUNCIL,

As presented to the General Committee, at Plymouth, July 29th, 1863.

THE Council of the Devon Association for the Advancement of Science, Literature, and Art have much pleasure, in this their first Annual Report, in being able to congratulate the Members on the complete success of the year's proceedings.

In establishing a Society of the character of the Devon Association, many difficulties present themselves; amongst these, not the least is that of obtaining good and efficient Officers, such as will not only carry out their respective duties satisfactorily, but will also, from their social position, their literary standing, and their courtesy and urbanity of manner, give a character to the proceedings of the Society, which must materially influence its future success. In obtaining these happy combinations in the Officers for the year, the Council believe they have been eminently successful.

Sir John Bowring, LL.D., F.R.S., &c., a name long associated with the literature of Europe, kindly consented to become the President, and The Right Worshipful the Mayor of Exeter, not only welcomed the Association to the city in his official capacity, but also kindly allowed his name to be placed amongst the Vice-Presidents. Sir Lawrence Palk, Bart., one of the Members of the County, A. H. A. Hamilton, Esq., and Dr. Shapter consented likewise to become Vice-Presidents.

The offices of Honorary Treasurer and Secretaries were filled respectively by W. Vicary, Esq., and C. Spence Bate, Esq., and Rev. W. Harpley; Honorary Local Secretary for the Exeter Meeting by H. S. Ellis, Esq.

It was thought by those interested in the formation of the Association, that the first meeting might appropriately be held in Exeter, as the chief city of the county, and the 14th of August was appointed as the day for the Association to commence its sittings. On this day, the Members assembled at the Clarence Hotel, and after the appointment of Officers, &c., the President delivered his address.

On the 15th, the Association met at eleven o'clock, when the following papers were read and discussed.

On the	"Statistics of the Deaf and Dumb."	*Dr. Scott.*
"	"Bovey Lignite Deposit."	*W. Pengelly, Esq., F.R.S.*
"	"Relations to Literature of a Provincial Association for the Advancement of Literature, Science, and Art."	*Rev. J. E. Risk, M.A.*
On a	"Sand-bed at Bovisand, Plymouth."	*C. Spence Bate, Esq., F.R.S.*
"	"The Ferns of South Africa, and a comparison of them with the Acrogenous Plants of Great Britain and N. America."	*W. S. M. D'Urban, Esq.*
"	"Age of the Dartmoor Granite."	*W. Pengelly, Esq., F.R.S.*

In the evening, the Members were entertained at a Conversazione given by the Devon and Exeter Graphic Society, when they had the opportunity of inspecting a large and choice collection of Works of Art, solely by Devonshire Artists; a variety of interesting objects of Natural History, and some rare and valuable Microscopic and Spectroscopic illustrations.

The last day of the meeting was devoted to a visit to that most interesting locality, the Bovey Heathfield, under the able guidance of William Pengelly, Esq.

The Council feel that the best thanks of the Association are due to the Committee of the Devon and Exeter Institution, for having permitted them to meet in their spacious Library for the transaction of the preliminary business of the Exeter Meeting.

The Council congratulate the Members on the financial state of the Association, the Treasurer having a balance in hand of £7 4s. 2d.

It having been determined at the last meeting of the General Committee that the second Annual Meeting should be held at Plymouth, the following Gentlemen have been selected to fill the various offices: President, C. SPENCE BATE, Esq., F.R.S., F.L.S., &c.; Vice-Presidents, W. DERBY, Esq., the Worshipful the Mayor of Plymouth, J. L. COLLEY, Esq., President of the Plymouth Institution, SIR JOHN BOWRING, LL.D., F.R.S., &c., SIR W. SNOW HARRIS, F.R.S., &c.; Hon. Treasurer, W. VICARY, Esq., F.G.S.; Hon. Local Treasurer, JAS. DABB, Esq.; Hon. Secretaries, REV. W. HARPLEY, M.A., F.C.P.S., &c., H. S. ELLIS, Esq., F.R.A.S.; Hon. Local Secretary, J. BROOKING ROWE, Esq., F.L.S.

The Council cannot close this report without again recording their satisfaction at the successful manner in which the proceedings of the first year have terminated, and hope that, at no distant day, the efforts of the Association will obtain for them a general acknowledgment that they have been highly instrumental in fulfilling the objects the Association has in view; viz., The advancement of Science, Literature, and Art in Devonshire.

The Council have published the President's Address, together with Abstracts of the Papers read before the Association, the Treasurer's Report, and the Bye-laws; and the Secretaries have forwarded copies of the same to every original Member of the Association, and to each of the Literary Societies and Institutions in the County.

They have the gratification also of reporting that through the courtesy and liberality of the Directors of the South Devon Railway, the Secretaries have been enabled to secure to the Members facilities in travelling to the next meeting.

An Account of the Expenditure and Income of the Devonshire Association for the Advancement of Science, Literature, and Art, for the year ending the 30th day of June, 1863.

1862–3.		£.	s.	d.
Local Secretary, Incidentals		4	5	6
Secretary's Postages, &c.		0	10	0
Mr. Parfitt, Issuing Tickets		2	0	0
Use of Room		7	12	0
Printing and Advertising, already reported	£9 0 9			
Paid since	9 8 6			
		18	9	3
Stationery		0	8	7
Coach Hire and Refreshments for Excursion to Bovey		5	14	0
Balance		7	4	2
		£46	3	6

		£.	s.	d.
Members' Subscriptions, already reported	£26 10 0			
Received since	5 10 0			
		32	0	0
Associates' Tickets		3	15	0
Ladies' Tickets		1	17	6
Excursion Tickets		8	11	0
		£46	3	6

WILLIAM VICARY, TREASURER.

Examined and found correct, July 29th, 1863,

JAMES DABB, } AUDITORS.
W. R. SCOTT, }

ADDRESS

BY

C. SPENCE BATE, Esq., F.R.S., F.L.S., &c.

THE growth of the most vigorous of natural productions is always the most slow in the early stages of its development. Nations the most powerful date their histories from a long genesis, and it is not to be supposed that societies of smaller proportions are to be exempt from the common law of progress. It is now just a year since this Institution was established, but in that year, while the world rolled on its axis, as it pursued its course round the sun, the intellect of man has achieved enough to make a nation great. Perhaps at no period in this world's history has there been an equal amount of daring research, as that which characterises the present age. And here we perceive the great advantage that the modern inductive philosophy has had in all recent enquiries, established, as they have been, upon the analyses of facts. It will be found necessary to impugn the data, in order to overthrow the conclusions. The progress of labour, whether in the field of science or historic research, when pursued in accordance with the evidence produced, however bold may be its flight, can never be considered rash; and however erroneous may be the conclusions arrived at, must ever command respect, and merit fair discussion. The promulgation of an error has never yet done harm to mankind, if its discussion be not prevented. The great enemy to truth is apathy. A calm and quiet contentment in the old ideas and dead opinions of our forefathers cramps the will and debilitates thought; and no greater curse can rest upon a people than a passive acquiescence with unexamined traditions. A false theory will soon dissolve in the atmosphere of free enquiry—have all the deceptive buttresses that give it support speedily knocked away, and the skeleton alone will be apparent in its hideous nakedness. In literature, no less than in science and art, has intellectual progress shewn an attempt at independent en-

quiry. It is for the benefit of free enquiry, for the advantage of liberal and enlightened discussion, that men of intelligence agree to band themselves into a society such as this present one. It is not a field for labour, but the arena on which the results of labour and industrious thought are made manifest. The history of a philosopher is the history of retired and hidden industry, of unknown and unappreciated labour. The subterranean current of lava is only known at the outburst of the volcano. The worker in the laboratory of undiscovered truths is visible only by his results. The calculations of Newton would have been unheard of, if the law of gravitation had not been demonstrated. It was the first flash of the electric telegraph that communicated to astonished Europe that Professor Wheatson had been long at work. It is not always that the results of labour are immediately appreciated. The pursuit of truth, whether in science or literature, should ever be the limit of desire. It must be a source of regret whenever any discovery or observation may give pain to the timid; but it is the duty of every student to "refuse to estimate the practical tendency of his speculations. If they be true, let them stand; if false, let them fall: but whether they be agreeable,—whether they be consolatory or disheartening, —whether they be safe or mischievous,—is a question not for philosophers, but for practical men." Actuated by this principle, instances have been multiplying, within the last few years, in which authors have published the result of their researches, both in history, literature, and science, that appear to be at variance with our long-cherished and deeply-rooted ideas.

In 1859, Professor Chowlson, of St. Petersburg, published a treatise on "The Remains of Old Babylonian Literature, preserved in Arabic Translations." Among these was "The Book of Nabathæan Agriculture," which is stated to have been written 1,300 years before Christ. The astonishment excited by this conclusion is heightened by the circumstance that the author of this work quotes a great number of works, which themselves, again, have quotations from other authors, thus suggesting whole centuries of culture and civilization before the time of Kuthami (the author). Professor Chowlson considers that a culture of some 3,000 years must be admitted before this author flourished. In separating into their respective classes the quotations which are mingled together in the *agriculture*, he finds at Babylon a rich and varied literature, fully equal to that which was developed among the Greeks one or two thousand years after,—a matured literature,

full of controversies, of schools, of sects, and of disputes between religion and philosophy. The writers of Babylon must have been thinkers with distinct views, discussing step by step, and in the minutest details, the opinions of their adversaries. The founders of Babylonian religions must have been philosophers gifted with clear perceptions, amicably opposing each other, and debating, one and all, like academical professors. Four or five hundred years before Kumathi, the chief personage of Babylonian literature, there lived a certain Yaudushadh, founder of natural sciences, and originator of a kind of Monotheism; before whom lived Dagmith, the founder of another school, which Dr. Chowlson puts at 2,000 years before Christ, and he speaks of various persons of Babylonian tradition in a manner which shows that he considers them as men of early antiquity. Indeed, long before Dagmith, lived many sages and priests, who endeavoured to introduce a worship freed from idolatrous superstitions, among whom he names *Adami* as the founder of agriculture in Babylon, acting the part of a civilizer, and hence named the *father of mankind;* Askulebitha, as the earliest astronomer; and Dewenai, as the most antient law-giver of the Shemites, who had temples, was honoured as a god, and called the *master of mankind.* It is in that distant period that Professor Chowlson states that literature existed, and before which lived the martyr Tammuzi, the first who founded the worship of the planets. The existence of a literature so remote in the history of civilization is so contrary to all our received traditions and ideas, that we can only consent to accept it after the most rigid investigations and critical analysis. Many scholars have stood forward as opponents to Dr. Chowlson, among whom the most important and able has been Professor Renan, a member of the Institute of France. In 1862, this latter author published an essay, "On the age and antiquity of the Book of Nabathæan Agriculture," in which he states his opinion that the work is not the labour of one hand, but of many. He further declares that, from internal evidence, the compilers must have understood Greek science; that they must have been acquainted with the institutions of Persia in their later development; and that they must have had access to the Jewish traditions in their apocryphal and legendary forms; and that it is his belief, instead of belonging to the thirteenth century before Christ, that it cannot be earlier than that of the third or fourth century after; in reply to which Professor Chowlson has promised the publication, *in extenso,* of the Arabic text of these re-

mains, which may supply some new information upon the subject.

The flood of light that has been thrown upon the history and language of the Egyptians by Bunsen, is too well known to require but a passing notice here; but before his reviewer in this county has undergone the full penalty due for his temerity, the Christian world has had to undergo one of its greatest surprises. J. W. Colenso, a native of Cornwall, and educated at Devonport, has recently published the first three parts of a critical examination of the Pentateuch, in which he boldly asserts that certain statements, being of an historical character, are capable of having their accuracy tested by critical analysis; that those statements which cannot bear the power of this test cannot be true, and, not being true, could never have been supernaturally revealed to man. Opinions and assertions such as these would, two centuries ago, have procured for their author the distinguishing mark of martyrdom; but in the present age, the capability of free discussion precludes the revival of old persecutions, and we may rest assured that the discussion that has commenced will be continued, and truth alone be made manifest. Thought, if allowed to act freely, without being repressed by political interference, checked only by moral influences, will necessarily attain to truth, appropriating goodness, and rejecting evil.

In contemplating the history of events from the time that the Protestant Reformers of the 15th century flung off the traditionary yoke of the Church, and demanded the individual right of private judgment in the interpretation of Scripture, it will be seen that the growth of human intelligence has been gradually directing its course towards, and at last must culminate in, an enquiry as to the authenticity of the *record*. This spirit of enquiry is one of the great features of the age, and cannot be set aside. The resistance to old interpretations must be met by arguments. Oppression by the law can only fall on some few whose places will speedily be taken by others, for the great struggle is not with individuals, but with the representatives of a class.

While the minds of the timorous have been disturbed by the researches in the field of literature, observations have been made in science that have been equally unanticipated, and at variance with our old ideas. The age of the world had been long hypothetically established, and so firmly had the length of time been fixed in our minds, that there were but few in whom it had not assumed the character and condition of a revealed truth. The discovery of facts in the progress of geological

research that were at variance with old opinions, was not accepted by the most ardent observers. In some instances, as mentioned by Col. Hamilton Smith in his "Races of Man," when, among some bones found in a limestone cave at Catte Down, one was supposed to have been that of a man, it was immediately thrown away. Thus the records were not accepted, and the strongest evidence was repulsed, because the mind of the enquirer had received as truth a foregone idea that he was reluctant to have disturbed. Though truth may be hid in dark places, it beams brilliantly when discovered. In this county, the presence of human implements in the vicinity of undisplaced bones of the cave bear, demonstrated clearly, that the maker of the implements must have been contemporaneous with the species of animal to which the bones belonged; for the two must have been washed into the cave together, since the latter must have preserved the ligaments of attachment until after it had been deposited in the sediment. It is not my intention to trace out the evidences of this most interesting subject, since, no doubt, it has been made familiar to most through the recent work of Sir Charles Lyell; but it may not be undesirable to dwell a moment upon the present stage at which the discussion of the subject has arrived.

No student in geology has ever yet attempted to approximate a numerative calculation of the human epoch. The only conclusion to which the extent of research has yet arrived at is, that man existed on this globe, and in this part of Europe, contemporaneously with the rhinoceros, hippopotamus, cave bear, and mammoth, all which animals, being extinct, have always been considered as belonging to a period extremely remote, when compared with historic evidence. The point on which discussion now rests, is not whether man was contemporary with the extinct animals, but on the age of the strata in which these animals are found, some affirming that the animals existed as inhabitants of this part of Europe until the recent period in geology, while others affirm them to be of much older date than is commonly appropriated to man's existence on the earth. It may be some time before sufficient evidence shall be forthcoming that will settle the point at issue, but most assuredly it is a problem that is to be worked out by means of severe geological investigation only. Discoveries of human remains and works of art will shew the strata in which they may exist, but the age of the strata is a subject for geological enquiry, and the determination of that point alone will solve the question. Professor Steenstrup took with his own hands a flint instrument from below a

buried trunk of a pine tree, in a peat bed in Denmark. These peat deposits vary in depth from ten to thirty feet: the lowest stratum is from two to three feet thick, above which lies another growth of peat. Around the borders of the bog, and at various depths in them, trunks of trees, especially the Scotch fir *(Pinus sylvestris)*, lie with their summits directed towards the centre, and which must have grown on the margin of the peat-mosses, and fallen into them. The Scotch fir was afterwards supplanted by the sessile variety of the common oak, of which many prostrate trunks occur in peat at higher levels than the pines; and still higher, the pedunculated variety of the same oak occurs with the alder, beech, and hazel. The oak has been in its turn almost superseded in Denmark by the common beech. Other trees, such as the white beech, characterize the lower part of the bogs, and disappear from the higher; while others, again, like the aspen, occur at all levels, and still flourish in Denmark. All the land and fresh water shells, and all mammalia, as well as plants, whose remains occur buried in Danish peat, are recent species.

In the time of the Romans, the Danish Isles, as now, were covered with magnificent beech forests. Eighteen centuries have done little or nothing towards modifying the character of the forest vegetation; yet, in the antecedent period, contemporaneous with bronze in plants, there were no beech trees, or only, at most, a few stragglers, the country being covered with oak. In the age of stone, the Scotch fir prevailed, and beneath one of these, at a considerable depth, a flint implement testified that man had already existed when these old forests flourished. It has been suggested by Mr. Patterson that it is not impossible, but that the preserved trees may represent those only which are capable of resisting decomposition—a circumstance that might account for the absence of beech trees in the lowest strata, but certainly never account for the presence of the antediluvian pine remains, the presence of which demands an altered and colder climate than that which now exists there. The story of the Abbeville flint implements must be familiar to all of us, as well as the subject of the discovery of a human jaw and teeth in the same strata. The existence of flint implements that have undoubtedly been forged, has thrown considerable suspicion on the genuineness of the bones found near them. This circumstance may remove much of the interest attached to the specimens, but by no means invalidates the truth of the question, inasmuch as that genuine flint implements have

been found both there and elsewhere, and these, unquestionably, are as strong evidence of the presence of man as the existence of his bones can be. Although a doubt is cast upon the genuineness of the bones, and the later flint implements be rejected as forgeries, yet there never has been a doubt cast upon the presence of the original type of implements from the same strata; and Mr. Prestwich unhesitatingly affirms his conviction that the strata in which they are found is of the older quarternary epoch. It is, therefore, by our being able to ascertain the age of the gravel in which the flints were found that we shall approximate to the age of the remains found in it.

Along the Baltic shore of Denmark exist in many places antient shell mounds, being the refuse of edible species left in the neighbourhood of the abodes of the inhabitants. These heaps consist of the remains of the mussel, cockle, periwinkle, and oyster—animals that exist in the present day. The three first of those in the antient mounds differ only by being twice as large as the same species found in the immediately adjoining sea, whereas the oyster is not found nearer than the entrance of the Baltic. These differences evidently arise from a change in the physical condition of the waters of the Baltic, inasmuch as the species alluded to are essentially marine, while the waters of the Baltic are less salt than those of the ocean. It is, therefore, a legitimate inference, that the alteration in the character of the Baltic that precludes the oyster from being an inhabitant, and has reduced in importance the dimensions of the littoral fauna, must have been a change in the waters of that sea from the originally marine condition to one of a brackish tendency, this either by introduction of fresh water, or the exclusion of salt, or perhaps both. Now, if an approximation could be made to the period when the Baltic underwent this change in its condition, we should have some idea of the time when the oyster dwelt there, and, consequently, when man resided upon the shores of Denmark. The cause of the freshness of this large inland sea is dependent upon the great influx of fresh water rivers, and the narrow entrance towards the Atlantic. The change in its physical condition must, therefore, have been dependent upon the elevations of Sweden and Norway to such an extent as to convert the Baltic into an inland sea. This was completed when the country of Finland was raised sufficiently to separate the White Sea from the Gulf of Bothnia. In the southern part of Sweden two large fresh water lakes exist, some 300 or 400 feet above the level of the

ocean. In these lakes, Professor Loven, the summer before last, found numerous species of marine animals, consisting chiefly of such as are known only in the Baltic, the extreme Arctic Sea, or in Lake Baikal, in the centre of Siberia. There can, I think, be but little doubt that these marine creatures must have retained that habitat from the time that Lakes Vettern and Venern were on a level with the ocean; that as the land raised, the bay became a gulf, and then a lagoon, and then a lake, gradually becoming fresher and fresher by the inpouring of fresh-water springs during the period of their being raised to their present elevation. Now, it appears to me, that when Lake Vettern ceased to be a portion of the Baltic, the latter became an inland sea, and, therefore, they both commenced losing their saltness about the same time. The whole continent of Norway is known to be rising out of the ocean: we have only to know the mean of the rate of elevation at Lakes Venern and Vettern to enable us to arrive at an approximation of the length of time it has taken to elevate these lakes to their present height above the level of the Baltic; that is, since the latter commenced losing its marine condition; in other words, since the Baltic ceased to be habitable to the oyster, and changed the character of the edible littoral species that are found in the Danish shell mounds. The species of animals existing in the Lakes Vettern and Venern suggest that when the lakes existed at a level, and in connexion with the Baltic, the climate possessed an Arctic character; in other words, it carries us back to the glacial period, yet it must have been before this that man dwelt in Denmark, for the shells in the mounds, not having undergone deterioration, must have been gathered from the Baltic before that sea had lost its saltness; that is, when all but the hills of Norway and Sweden were beneath the sea. A calculation, based upon a single instance, can in itself be of little worth; but if in different parts of Europe, where the traces of man are found, many opportunities of making such calculations should occur, and all, or most of them, terminate in similar results, we may then assume that those results, more or less, approximate a correct date. Evidence of somewhat parallel nature appears to exist in our own county, which, if carefully worked out, might assist towards the solution of the question.

There is evidence that many of our valleys were filled with *débris* to somewhere about 150 feet. This is shown in the presence of gravel on the sides of the valley of the Exe, at the height of 130 feet, on the top of Windmill Hill, and in the cave

at Brixham. On Plymouth Hoe, the *débris* of Dartmoor rocks exist in the form of large beds of sand and pebbles of quartz, charl, and greenstone; as, also, at a lower level on the opposite side of the Tamar, at Cremyl. On the hills about St. Austell exists gravel, containing stream tin, among which antient implements of human industry have been found. All these could not have been brought to their respective positions had not the intermediate valleys separating them from the parent rocks been filled at least to the height of these present localities. It is, therefore, highly probable that the same influences that removed the *débris* from the valleys, filled the caves and fissures with gravel and animal remains. Not only have the valleys been excavated, but portions of land, probably representing great geological epochs, have been swept away. Of this I think that we have evidence in the presence of flints and nodules of chalk, containing fossils of the old formation entombed beneath the modern *débris* at Bovisand Point. This appears to me to be the last remnant that represents the greensand or chalk formation that once covered the hills in this locality. Around our sea coast many traces of the antient sea margin are to be found, shewing that in Devonshire, at that time, the land stood at some ten or twenty feet lower level than it now does. If the raised sea beach at Brighton be coeval with those on our own coasts, they are, upon the authority of Sir Charles Lyell, of greater antiquity than the deposits of the glacial boulders of Suffolk. In the North of Britain there are two lines of raised sea beaches, the uppermost of which supports the glacial boulders. We may, therefore, justly argue that our beaches under the Hoe and at Torbay are coeval in date with the highest line of the Scottish sea levels. Mr. Lyell shews that there is a reasonable ground for supposing that the second or lower line of antient sea margin dates from the period of the occupation of Britain by the Romans: that since the Romans built the wall of Antoninous, and occupied the old harbour of Atalerva, on the Forth, an elevation of from twenty to thirty feet has taken place. We moreover know that the latest movement on our southern shores has been one of depression. We see it in the submerged forests—in Swansea Bay, at Penzance, Bovisand, Bigbury Bay, Dartmouth, and Torbay. We hear of it in the old tradition that gave the armorial bearings to the Vyvyan family, and in the lost territory of Lyonesse. I think that a close analysis may show that while the traditionary lands of the South are of the same epoch as the lower Scottish sea beaches, the higher are coeval with our Southern

raised beaches, and the drifts that fill our crevices and caves with the remains of extinct animals and man. But the evidences of antique man appear to be forthcoming from every part of the world, and wherever found, the geological variations are so inappreciable as to make it appear as if man must have existed in America, Europe, &c., at the same remote period; whereas, in point of fact, the presence of primordial man in the New World must have been modern, when compared with the inhabitants whose antique remains lie entombed in the North of Europe; and those exhumed in England must represent a much later date in the solar history of the world to that of the presence of man in the South of Europe, Southern Asia, or perhaps Central Africa. In accordance with this assertion are the recent researches of M. J. Desnoyers. Among the numerous cave deposits, as well as caverns and tumuli that have been examined, bones of many animals, modern as well as extinct, have been found. Many of these exhibit marks and cuttings that can be distinguished readily from accidental fractures, or the impressions made by teeth of gnawing animals. A careful study of these will enable an observer to determine their character, and distinguish between those made by a file, a saw, or an axe. In relation to this subject, M. Desnoyers has been examining the remains of animals to enable him to determine whether or not the several marks of injury impressed upon them are such as could be attributed to other than accidental agencies. He says that—"Fossil bones of *Elephas meridionalis*, of *Rhinoceros Leptorhinus*, of *Hippopotamus major*, of several great and small deer, of several species of ox, and species of other mammals, considered as characteristic of the upper tertiary, *i. e.*, pleiocene deposits, and discovered in an undisturbed strata of this geological period, bear numerous and incontestable traces of incisions, striæ, and cuts. These notches and striæ are perfectly analogous to those which have been observed on fossil bones on other more recent species of animals, some extinct, and accompanying *Elephas primogenius*, *Rhinoceros tichorinus*, *Hyœna Spilea*, and others yet living at the present day, such as the reindeer and the aurochs, found in the bone caverns and in the deposits of transported materials or diluviums. Similar markings have been recognized on numerous bones of existing kinds collected in the excavations of Gaulish, Gallo-Roman, Breton, and German establishments and tombs. These authenticated marks on the most appear to have, in very great part, the same origin as those on modern bones, and to be capable of being attributed only to

the action of man. The deposit of St. Prest, in the neighbourhood of Chartres, unanimously recognized as Pleiocene, and certainly as anterior to all the Quaternary deposits, which contain *Elephas primogenius*, contains numerous bones of *Elephas meridionalis*, and of most of the great species characteristic of the upper tertiary deposits, on which are noticed these notches and striæ. From these facts, there is every appearance of probability that we are justified in arriving at the conclusion, that man lived on the soil of France *before the great and first glacial period*, at the same time as *Elephas meridionalis*, and other Pleiocene species characteristic of the Val d'Arno in Tuscany; that he has struggled with these vast creatures anterior to *Elephas primogenius*, and the other mammals whose bones have been found mixed up with the remains and indications of man, in the deposits of transported materials, or Quaternary strata of the great valleys and caverns."* This, therefore, gives evidence of the presence of man back to an era in the geological history of the world considerably anterior to that of the Abbeville drift or the Brixham cavern.

I am happy to be enabled to inform the Society that there is now a cave undergoing the process of exploration by Mr. Pengelly, at Torquay. It is too early to do more than allude to the circumstance, for although the indications of the presence of man are numerous and varied, yet the history of the deposit should be read entire, in order to avoid erroneous conclusions.

Among the numerous specimens of human remains that have been found in the caves and drifts of Europe, some few more or less perfect skulls have been obtained. Some of these appear to be so unlike to that of man as to have been mistaken by competent anatomists as having belonged to some quadrumanous animal, while others have exhibited appearances compatible with a high mental condition of the human race. The discoveries made, varying somewhat in appearances, have induced anatomists to reconsider the subject, and to endeavour to ascertain a correct idea of the anatomical points that distinguish man as an animal from the nearest approximating genera among the mammals. This enquiry has given rise to much discussion, and unfortunately it has

* Since the reading of this paper, the President has been informed that experiments have been made in the Zoological Gardens that appear to overthrow the opinions of M. Desnoyers. Bones, gnawed by the Porcupine, closely approximate to some of the markings on the fossil bones that are asserted to have been artificially made.

been conducted with a feeling that is much to be regretted. In order to make the subject clear, it may perhaps be desirable to trace the outlines of the leading opinions of anatomists as to man's position among the primates. Linnæus, who knew nothing of the anthropoid apes from his own observation, was induced, from trusting to the fictitious inventions of travellers, to class the ourang-outang as a second species of the genus *Homo*, and this he followed by a third, which he named *Homo caudatus*, from the circumstance of its possessing a short caudal appendage. This arrangement of the father of modern natural history was set aside by the more accurate observations of Blumenbach, who, preserving man and the manlike apes in one order, primates, distinguished man, who possessed two hands, from the apes, in which the feet were formed upon the type of the hands, and which, therefore, possess four hands. The genus *Homo* he placed in one family, *Bimana;* the several genera of apes he placed in a second family, which he named *Quadrumana*. This general arrangement was supported by the authority of Cuvier. Later still, Professor Owen communicated to the Linnæan Society a paper on the Characters, Principles of division, and Primary groups of the Class mammalia, classifying them in accordance with their cerebral variations. Accordingly, founded upon his observations, he so widely separated *man* from every other species of animal, that he placed him into a sub-class by himself, for which he proposed the name *Archencephala*. The characters that induced him to arrive at this conclusion were, that the *cerebrum* bears a less relative proportion to that of the *cerebellum* in the highest apes than in man; that in the latter the cerebrum overlaps and covers the cerebellum, extending so far back as to possess the character of a third lobe; that in the posterior horn of the lateral ventrical exists a small ridge of unknown use, to which the old anatomists gave the quaint name of *Hippocampus minor.* Thus, we perceive, with progress of time, the relation in which man, as an animal, stood to the primaties, has been gradually separating. That Linnè should have arrived at erroneous conclusions from his imperfect and somewhat fictitious data, is scarcely beyond legitimate anticipation; but that the great and philosophic Cuvier should have rested his generalization upon incomplete evidence, is a subject of wonder and regret. The conclusion of Blumenbach that the posterior limbs of the animals must necessarily be hands, because they were capable of being used as such, required, on the part of Cuvier, a strict anatomical investigation to be demonstrated true before he admitted

it to be the basis of a natural classification in science. This investigation appears to have been reserved for Professor Huxly, and this he has done with a clearness and precision that establishes the fact, that however in external form the hind limbs may represent the hands, they are undoubtedly true feet, modified externally to suit the purposes of hands. This opinion is in accordance with that of M. Isidore G. St. Hilaire, who repudiated the division of Blumenbach and Cuvier as being either too near, if we take into consideration the intellectual capacity of man, and too far off, if we merely consider the organic affinities. It was, therefore, with some surprise that anatomists learned the announcement of Professor Owen, that there was evidence in the structure of the brain of a man, that essentially distinguished him from all other animals, and widely separated him from his nearest ally. The facts on which this assertion rests have been met by a denial on the part of a number of the leading anatomists of Europe, so that we are bound to conclude that the brain of man offers no apparent structural condition from that of the anthropoid apes. The only distinction that has been established by anatomists is that of the size of the brain, which, in the largest anthropoid apes, is scarcely one-half of that of the smallest man. But this, in a zoological point of view, loses much importance from the fact, that there is nearly as great a distinction in the relative proportions of the brains of the several genera of apes: nor do we always find that the highest degree of intelligence, either in the lower animals or in man, is always in proportion to the relative size of the brain. The considerations of the relationship which man, as an animal, bears to the organic world, leads to the consideration of the theory of the variation of species from natural selection propounded by Mr. Darwin and Mr. Wallace some two or three years since. The opinions of these naturalists have too long been made public, and been too generally discussed, for me to dwell on them in this place, farther than to communicate the most recent information that we have upon the subject. The chief doctrine in the theory is, "that species are not immutable;" the objections to which are, first, in the supposed existence of "atavism," or the tendency of all varieties of species to return to their original form when the cause of variation has been withdrawn, and in the circumstance that, while considerable variations are known to be effected in the artificial selection of animals, no change is known to have taken place in the form or character of any animal not influenced by the power of man; secondly, that geological research affords us so

many gaps in the scale of progression, that the evidence derived from the absence of forms, though negative in condition, is almost positive in its strength; thirdly, that the recognized organic structures upon this globe, as exhibited in the earliest known Palæozoic rocks, are of a too highly developed character to be the earliest form of life.

The replies to these objections are, first, that certain plants that we have long been accustomed to consider as undoubtedly distinct as species, are now known to have been derived from the same. This is true as regards the cowslip and primrose; and, secondly, that no creole, or "half-breed" race, exists; that it invariably dies out, unless sustained by new blood. Thus we see on the one side plants that have long been recognized as distinct species, are capable of producing each other, as it has been affirmed that only varieties can. And on the other hand, man, who is popularly recognized as consisting of a single species, dying out when two varieties intermingle. The reply to the next objection is, that the theory is not a progressive one, and that research in the field of geology is as yet but small, and that the preservation of the species of the past life of the globe is but imperfectly preserved. As an example: for many years the presence of footmarks in the Oolitic and Permain rocks have told us that birds of large and somewhat peculiar forms must have lived in tolerable abundance; yet it is only within this last year that a specimen has been found, and now I believe that only two are known, and these are imperfect. We have often heard it said that, given a bone or a tooth, and an anatomist can construct the animal; but the discovery of this antient bird has dispelled, to a large extent, this confidence. The fossil bird differs from all known birds to so great an extent, that those naturalists who first examined, pronounced it to be a feathered reptile; but close and accurate examination has discovered it to be a true bird, but departing from the recent form, chiefly in the possession of a long and vertebrate tail, every articulation of which supports on each side a single fully plumed feather. The reply to the third objection is, that we are by no means certain that the earliest forms of life have been preserved. The old Palæozoic life is not clearly written. The organism formed in the oldest strata are by no means satisfactorily interpreted, and there is every reason to believe that the great changes that the rocks have undergone since their deposition as mud, must, to a large extent, have obliterated the remains that were entombed. This is specially true of the metamorphic rocks; but recent investigations seem to

suggest the probability that evidence of past life may yet be found in rocks, where it has hitherto been deemed impossible.

It has long been taught in geological science that granite is an eruptive rock, but notwithstanding the resemblance of its mineral composition to trachyte, it is by no means to be regarded as such, and probably is not strictly igneous. The quartz which is its base has frequently been found to be impregnated with *organic* and *bituminous matters*, besides water and occasionally certain *resins*. All the component parts of granite are capable of being produced with water, and without intense heat, and it moreover is capable of being fused with a considerable alteration of character. In fact, all the phenomena attendant upon the introduction of granite, prove that it was brought into contact with the rocks next to it in a heated condition, but that it was not erupted at a high temperature, although, perhaps, at a temperature considerably above that of the earth's surface at present. There is, moreover, reason to believe that granite differs little in its origin from the fine mud that accumulates at the bottoms of rivers, lakes, and seas, where the material has been collected by merely mechanical aggregation, or through the co-operation of organic life. This appears, likewise, to be true of mica-schist, in which Mr. Sorby has very recently established the presence of ripple drift markings. And the result of the most recent chemical and physical enquiries shews that we have no proof of a fluid state of the earth's interior at any attainable depth in any of the rocks that are presented to us at the earth's surface. Geologists have been accustomed to assume the original fluidity of the earth, and draw conclusions of the progressive rate of its cooling. The thickness of the earth's crust at this present period has thus been calculated to be solid to the depth of a hundred miles, at which distance beneath the surface the heat is said to be sufficiently great to preserve the substance in a fluid condition. Professor W. Thompson has recently calculated, from established observations, that the solid substance of the earth must consist, on the whole, of very rigid material, to allow the actual height of the tides, and the amounts of precession and nutation to be what they are. Since, therefore, the surface of the earth is *less* rigid than glass, it follows that the interior must be *more* rigid than steel. He, therefore, concludes that no thickness of crust less than half the earth's radius could enable our planet to preserve its figure with sufficient rigidity to allow the tidal phenomena—a conclusion that is at variance with the hypothesis

that the earth is a mass of melted matter enclosed in a hollow shell, open to volcanoes, and disturbed by earthquakes.

The verification of Professor W. Thompson's calculations is of the utmost importance to theoretical geology. The explanation of earthquakes and volcanoes is to be reconsidered; the more, since the statistics recently published by Mr. Mallet suggest the idea that they have no reference to any fluid centre, but are, comparatively, superficial. The deductions and generalizations, obtained from the elaborate lists of Mr. Mallet and M. Perry, suggest that earthquakes are not chance disturbances, but phenomena of a regular kind, and capable of being brought within mathematical investigation; and the tabulated facts appear to indicate that earthquakes are more frequent at certain seasons of the year, at certain lunar periods, or under certain conditions of surface temperature of the earth, than at any other times. In corroboration of the absence of any internal heat of the earth's centre, Professor Tyndal's experiments shew that moisture rapidly absorbs heat; that nineteen-twentieths of the sun's heating power are absorbed by the moisture of the air; that the presence of any internal fire would cause an amount of evaporation from the earth's surface, that must impede the sun's rays to an extent that would be injurious to organic life. He has also shewn that, by the increase of moisture in the air, heat radiates less rapidly. It therefore would appear that the balance of heat received from the sun, and the amount of loss from radiation, has probably existed at all periods of the geological history of the earth, very nearly as at the present time.

The calculations of Mayer, and the experiments of Joule and Tyndal, upon heat, have resulted in the establishment, upon an apparently firm basis, of the theory that "heat is the vibration of the ultimate atoms of matter."

They have shewn, that the exchange of motion for heat is a conversion from one into the other; that the amount of motion that is lost is exactly represented by the work that is capable of being performed by the heat that is gained. As an example: A ball, falling from a given height, upon being suddenly checked by coming into contact with another body, evolves heat. Now, if that heat be collected, it is capable of lifting up that ball to the height from which it fell; in other words, the heat that is generated is equivalent to the amount of motion that is lost; in fact, the motion is converted into heat. The amount generated by collision increases in accordance with the height, in the proportion of the square of the velocity. Calculating upon this principle, the weight and

velocity of any projectile being known, we may ascertain the amount of heat that would be generated upon its motion being destroyed. For example: We know the specific gravity of this earth, and the velocity at which it travels through space. We may, therefore, calculate the amount of heat that would be generated, supposing this world to be stopped in its orbit. Mayer and Helmholts have made this calculation, and found that the quantity of heat generated by this colossal shock would be quite sufficient, not only to fuse the entire earth, but to reduce it in great part to vapour. Thus, by the simple stoppage of the earth in its orbit, the elements might be caused to melt with fervent heat! The amount of heat thus developed would be equal to that derived from the combustion of fourteen globes of coal, each equal to the earth in magnitude!

Bacon, whose great mind appears as if it had the power of grasping all subjects, enunciated that heat is motion. Locke also seems to have arrived at the same conclusion. But these assertions can only be looked upon as being successful conjectures, since they were opinions in advance of and unsupported by experimental evidence.

It therefore has remained until our day to see the idea established as a theory. For although the fact, that heat is a force, has long been acknowledged, yet the opinion of Boyle, that heat is a material that existed ever in a latent or active condition, in all bodies, long held sway in the schools.

Heat, then, is motion given to the ultimate particles of matter: its source is the sun, from which all heat and motion are derived; it obeys the same laws as light, and correlates with sound and gravitation. Let the solar rays fall upon a surface of sand; the sand is heated, and finally radiates away as much heat as it receives. Let the same beams fall upon a forest, the quantity of heat given back is less than the forest receives, for the energy of a portion of the sunbeams is invested in building up the trees. Without the sun, the reduction of the carbonic acid cannot be effected, and an amount of sunlight is consumed equivalent to the molecular work done. "But," continues Professor Tyndal, "we cannot stop at vegetable life, for this is the source, mediate or immediate, of all animal life. The sun severs the carbon from the oxygen; the animal consumes the vegetable thus formed, and in its arteries a re-union of the severed elements takes place, and produces animal heat. Thus, strictly speaking, the process of building a vegetable is one of winding up; the process of building an animal is one of running down. The

warmth of our bodies, and every mechanical energy which we exert, trace their lineage directly to the sun. The fight of a pair of pugilists, the motion of an army, or the lifting of his own body up mountain slopes by an Alpine climber, are all cases of mechanical energy drawn from the sun. Not, therefore, in a poetical, but in a purely mechanical sense, are we children of the sun. Without food, we should soon oxydize our own bodies. A man, weighing 150lbs., has 64lbs. of muscle; but these, when dried, reduce themselves to 15lbs. Doing an ordinary day's work for 80 days, this mass of muscle would be wholly oxidized."

While this theory was being established, Dr. Joule has, by a very ingenious mechanical contrivance, been able to demonstrate the existence of heat in the moon's rays. Many attempts have previously been made by philosophers, but the only one that has been at all successful was made by Melloni, who, with a large polygonal lens, converged an image of the moon upon his thermo-electric pile, which deflected his needle to 30° or 40°. This deflection indicated warmth. This is the only positive evidence we have had that there is any heat in the lunar rays; and this experiment has, from the great nicety of its adjustment, not been successful when attempted by others. Dr. Joule's apparatus is very simple: it consists of a glass vessel in the shape of a tube, about two feet four inches in diameter, divided longitudinally by a blackened pasteboard diaphragm, having a space at the top and bottom, each a little over one inch; in the top space, a bit of magnetized sewing-needle, furnished with a glass index, is suspended by a single filament of silk. The slightest excess of temperament, on one side over that of the other, must occasion a circulation of air, which will ascend on the heated side, and descend on the other. The sensibility of the instrument may be increased to any extent, by diminishing the directive force of the magnetic needle.

While alluding to the moon, I would mention that the long vexed subject of a lunar atmosphere appears to have been solved, by a clever mathematical calculation of the amount of refraction of the light of a star, as it passes to this earth through a lunar atmosphere. This is shewn by the time that the star remains in occultation, when compared with the time that it takes in traversing the same amount of space when not hid by the moon's surface. By this means, Professor Challis has demonstrated that the moon has an atmosphere of her own. Before we part from the subject of light and heat, it is but right that you should be informed of M. *St. Victor's* recent successful experiments in the possibility

of being able to photograph pictures with the natural colours. M. St. Victor has long been engaged upon this subject, and it is some time since that he announced his power to obtain red, blue, or green, but that he failed in producing a yellow. But in January last, he announced to the Academy of Sciences, at Paris, that he had at last succeeded in obtaining yellow, by preparing his silver plates in a bath composed of hyperchloride of soda, instead of potash, and that he produced specimens that hold out great expectations of complete success. He has not yet absolutely succeeded in fixing the colours. They remain perfect as long as they are in the dark, but disappear when exposed to the light. But, in this respect also, M. Niepce, by the application of gum-benjamin as a varnish to the plate, has managed to preserve the colours for three or four days, even when exposed to a July sun. The recent memoir states, that all compound colours are decomposed by the heliochromic process. The examples given are highly interesting; as, for instance, if a natural green, such as that of emerald, or arsenite of copper, be presented, it is reproduced on the plate; but if the green be a compound, formed, for instance, of chrome yellow and Prussian blue, that of a textile fabric, dyed with a mixture of the two colours, or produced on glass in a similar manner, the photograph produces a blue colour, in whatever manner it is treated. Moreover, when transparent blue and yellow glasses are used, so as to produce a green, it matters not whether the blue be before, behind, or between the two glasses of the other colour, the effect is invariably the same: no matter how long it is exposed to the light, the result is always blue. An orange effect produces invariably red. A red and blue glass together, produce at first a violet, because the plate itself is red; but the ultimate result is blue. White paper, coloured green by means of the recently discovered Chinese green, which is made from the juice of the buckthorn, has but a sluggish action upon the heliochromic plate; but, after long exposure to the light, a blue green is produced; and the same effect is produced from a grass green colour. Bluish green foliage, such as the leaves of the dahlia, produces a tint that is almost positive blue. The eye of the peacock's feather is well rendered in the camera, the tints appearing to vary between blue and green.

Apart from the value that these experiments possess, in relation to photography, they appear to promise considerable assistance in the analysis of the solar spectrum; for it is evident the *experiments* made in the attempt to fix the *colours of nature on heliochromic* plates, go far to confirm

the new theory, which recognises the existence, not of three, but of seven primitive colours; viz., violet, indigo, blue, green, yellow, orange, red. But the practical importance of these experiments is yet to be ascertained. We shall have a paper at this meeting of our association, in which the author expects to establish that the prismatic colours on the surface of mother of pearl, attributed by Sir David Brewster to fine striæ on the surface, is, in fact, due to the presence of a number of very thin laminæ of nacre. The researches of Bunsen and Kirkchoff, in the solar spectrum, have increased in practical importance. Besides the discoveries of several metals, analyses of the spectra of the fixed stars and planets have been attempted with sufficient success to inform us, that most of those metals which add to the convenience and happiness of ourselves upon this earth are common to the heavenly bodies.

The delicacy of analysis by means of the Spectra has indubitably been established; there is little doubt but that thallium, which has now been procured in very considerable quantities, was, from its resemblance to lead, confounded with it by Berzelius. This metal was first detected by Mr. Crooke by the remarkable green line that it gives in the spectrum.

Independently of the spectrum given by the solar ray, it appears probable, by the experiments of Professors Stokes and Miller, that the so-called invisible spectra of the actinic ray will play as important a feature in the history of science as the previous.

But while the new and attractive branch of chemistry has been progressing, the old stem has been as steadily pursuing its path of discovery.

It is now nearly sixty years since Sir Humphry Davy proved the existence of metallic bases in certain alkaline earths. Although this long period has elapsed, it is only recently that any of them have been known to commerce. Aluminum has for some few years been used in connection with ornamental decoration. Lately, however, magnesium, which exists on the earth's surface in such great quantities, that the sea alone is estimated to contain a mass equal to 160,000 cubit miles. It would therefore appear, that the extraction and application of such metals as this, together with calcium and silicium, each of which is far more abundant than iron, afford a large and splendid field for future chemical research. That magnesium will soon become an article of commerce, the recent researches of Mr. Sonstadt give much hope; and, if report speaks truly, we may speedily expect to have added to our use a metal capable of receiving a polish *equal to silver*, and cheaper than iron.

We must not forget, in enumerating the advancement made in knowledge, to mention the increase that has of late been received from the adventuresome spirit in geographical discovery. Mr. Wills, a gentleman of this county, who unfortunately has fallen a victim to his enterprising spirit, has opened to our knowledge the interior of Australia, thereby dissipating the speculative desert of sand that geographers supposed to exist. The source of the old Nile appears to have at last been approached; the seat of the King of Dahomy reached; while Mr. Bates and Mr. Wallace have explored the forest banks of the far off Amazon and the interior of the Australasian islands. On the borders of a high mountain lake, in the Bolivian Andes, have been discovered the remains of a city, antient to the old Incas of Peru, ornamented with wonderfully perfect sculptures and unknown legends. The lost people, if we may judge from a specimen of a child, as well as the cast of a skull brought from the same locality, in this instance offers unusual peculiarities. The head is long and oval, and remarkable from the possession of one more bone than is usually found to exist in skulls.

Nor are these features incompatible with considerable progress in the arts, if we may judge from the beautiful colour of the textile fabric in which the body is wrapped, as well as from the fineness of the weaving and the character of the pottery found with it.

In art the age is progressing. In no period of our history have paintings been so much sought after as in the present day. The history of British art is intimately connected with the western counties. That the existing genius of this county bids fair to retain this recognised position, the exhibition of paintings of local artists that we had at the meeting at Exeter, as well as that which is offered to the inspection of the members during this meeting, fully support.

The restoration of our old churches and cathedrals testifies to the improvement in architectural feeling.

Moreover, public taste appears to demand an increase of sculpture, and thus our towns have been doing homage to acknowledged worth. The statues of Lord Fortescue and Sir Thomas Dyke Ackland at Exeter, to Mr. Wills at Totnes, Sir Humphry Davy at Penzance, bear ample testimony.

There is yet a feature in this Society to which I have to allude. In our endeavour to afford an opportunity for all the thinking men of the county to assemble and meet together once a year, we have not forgotten, as our last year's

report can testify, the great advantage that may be derived from the discussion of subjects relating to social science. In this respect we differ from other scientific bodies; and it is a distinction that, I think, will prove advantageous; for if our present prosperity be prophetic of our future greatness, we can separate every distinguishing element of the Society into a distinct section to itself.

It is highly important that the relation of health and morality to the welfare of mankind should be studied upon scientific basis. In a paper in our last and only report, we learn, upon strong evidence, that a large proportion of deaf and dumb cases is the result of too close consanguinity of marriage. It may be that well-arranged statistical evidence may demonstrate that much of the misfortunes and vices that taint humanity may be found to be amenable to certain laws, the knowledge of which is the key to the remedy. It is gratifying to know, that since the effort has been made to study the subject as a science, health has greatly improved, and the life of man is lengthened; and history shews us that the national morality never stood so high.

The history of civilization tells us that national failings and national virtues remain the longest among the uneducated classes. If we look for a remnant of a past language, we seek it in the conversation of individuals who exist in places where the besom of modern progress has never reached. The kindly welcome and the unsuspicious heart exist where the iron heel of civilization has crushed the lightest. Crimes and vicious habits are the abnormal accompaniment of rapid advancement in knowledge and wealth. It is a noble effort and a noble study to calculate upon scientific data the causes which lead to the deterioration of one portion of mankind in social progress in a more or less constant ratio with the amelioration of the other, and it is gratifying to know that statistics shew an average decrease in crime for the last few years. It is a stimulant to the exertions of the philanthropist who works in the conviction, that

> "He prayeth best who loveth best
> All things, both great and small,
> For the dear God who loveth us,
> He made and loveth all."

It only now remains, gentlemen of the County Association, for me to welcome you to Plymouth, and I hope that you will find that the efforts of our local committee have been such as to contribute to your comfort, and the success of the meeting.

Fig. 1.

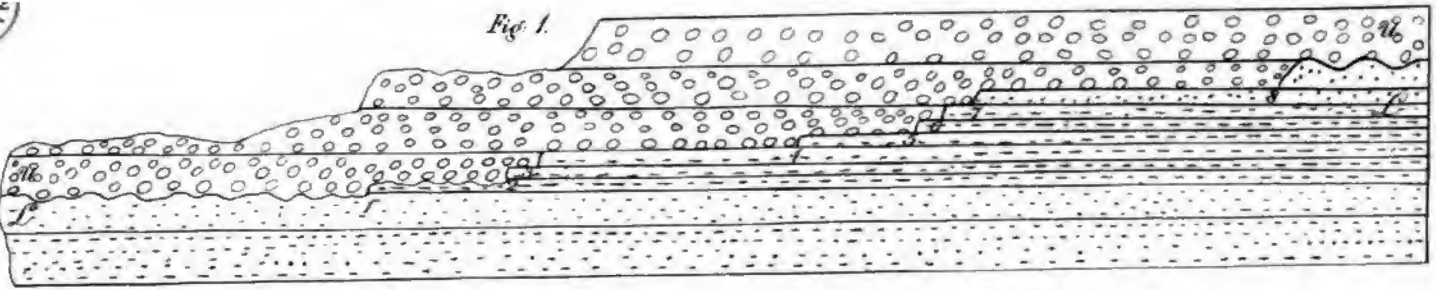


Fig. 2.

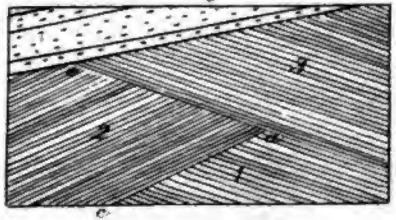


Fig. 3.

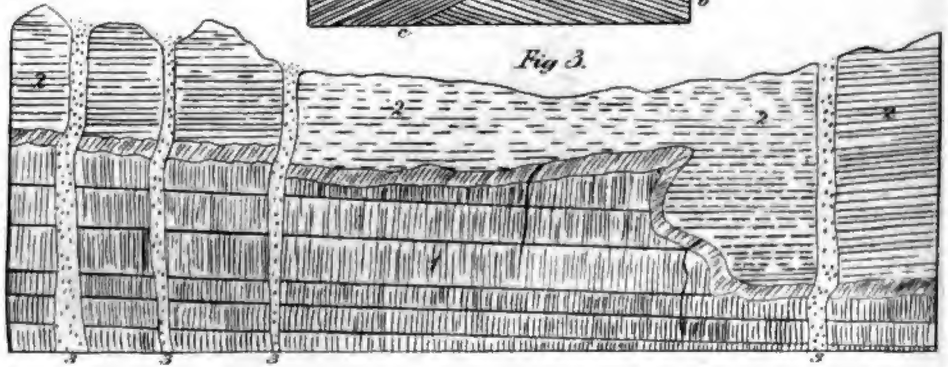
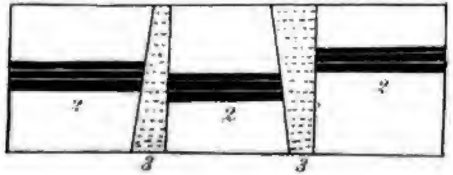


Fig. 4.



ON THE CHRONOLOGICAL VALUE

OF THE

NEW RED SANDSTONE SYSTEM OF DEVONSHIRE.

BY W. PENGELLY, F.R.S., F.G.S., F.A.S.L., ETC.

PROBABLY most persons are prepared to assent to the proposition that the Antiquity of the Earth was greatly underestimated by our ancestors, and may be willing to admit that the units with which the geologist has to deal are to be valued in, at least, thousands of centuries. Indeed, it seems impossible that any one can rise from the intelligent perusal of our standard geological works—having followed the author in his descriptions of the vast piles of mechanically formed rocks; of the processes of denudation, transportation, and sedimentation which they betoken; of the fossils, always related yet ever varying, which they contain—without, not merely a recognition of the incalculable age of our planet, but a feeling of oppression under the load of millenniums which has been heaped upon him.

And if this be true of the closet student, *à fortiori* it is true of the field geologist. To him the processes have a reality, a distinctness, a chronological value, to which no one else can attain. Yet even *his* clearest views are but dim glimpses of portions only of a remotely distant whole. *He* has not yet been face to face with the gigantic truth.

It is at present, and probably always will be, impossible to estimate, even roughly, the age of the world in years. We can reduce avoirdupois to troy pounds, but not geological to astronomical time. We know not how many rotations on her axis, or revolutions round the sun, the earth made during the deposition of a layer of detritus; we cannot give the value in days or years of a bed of limestone reared by the labours of generations of humble polypes; nor can we resist the conviction that the time represented by the fossiliferous formations is vast beyond our comprehension.

Nor are we sure that the oldest fossil-bearing bed with

which we are acquainted was coeval with the commencement of organic existence. Moreover, could we certainly find the first-born stratum—whether Azoic or Palæozoic—it would be a consequence and a proof of a world of still higher antiquity, —a world whose rocks, having grown old, succumbed to wear and tear and furnished the detritus which was to usher in a new order of things, that of sedimentary deposits.

Various facts, suggestive of the foregoing train of thought, have recently come before me, bringing with them striking and concurrent evidence of the slow formation and great chronological value of the New Red Sandstones of Devonshire. These facts I beg to lay before the Association.

The rocks in question are eminently detrital, and consist of Conglomerates, Sandstones, and Marls. They belong to either the Lower or the Upper Trias; that is to say, they constitute one, or possibly part of one, of the three great sub-divisions of one of the units of the geologist, and that by no means one of the most important in the scale.

They may be said to occupy the whole of the county east of a line extending from the centre of Torbay to Porlock, in West Somerset; not unfrequently, however, they are concealed by more modern deposits, but valley sections, every here and there, disclose them as the basis on which the latter rest. Peninsular masses penetrate far into the country west of the line just mentioned, whilst several widely-separated outliers show that the red rocks have lost much by denudation, and that they formerly covered a much larger area than they do at present.

In the fine cliff section, extending, with a small interruption, from Roundham Head, in Torbay, to the Flat Point, near Budleigh Salterton—a distance of nearly fifteen miles, measured in a straight line—the average dip is about $15\frac{1}{2}°$ in the direction N., $44\frac{1}{2}°$ E.; that is very nearly the bearing of the latter from the former point: so that, confining ourselves to this portion of the formation, the foregoing data give a thickness of fully four miles for this fraction of the deposit. Though the *faults* which occur in the section are unimportant, and many of them calculated to enhance this result, it may be readily admitted that it exceeds the truth; nevertheless, it shows that the red rocks are of enormous thickness, and contain a great volume of rock *débris*.

Now, nothing can be more certain than that the rate of sedimentation is, on the whole, limited by that of the requisite previous denudation. A wall cannot be built faster than the stones are quarried or the bricks made; nor can a

mass of detritus be deposited more rapidly than the pre-existent rocks are destroyed. Moreover, it is not the *destruction* merely of the ancient rocks which we have to consider, but the conversion, in many cases, of the *débris* into fine sand or mud. No one can resist the story told by a bed of conglomerate; every pebble in it is emphatic respecting its derivative origin; they all "prate of the whereabouts" of their parent beds; whilst, in many cases, beds of equal volume when composed of fine sand are passed by unheeded. Nevertheless, the slightest reflection shows—all other things being equal—that, as an exponent of time, the value of a bed of detrital matter must be great in proportion as its materials are fine; just because it takes more wear and tear, and therefore longer time, to reduce a given rock-fragment to fine sand or mud, than it does merely to remove its angularities. Apply this to the voluminous red rocks of Devonshire, and they become the representatives of an amount of time beneath which the mind staggers.

Hitherto we have taken the existing amount of sedimentary matter as the *measure*, as well as the monument, of the amount of denudation,—the fabric, more correctly the ruin, left for our inspection, as the index of the work and time expended in rearing it. This, though by no means an unusual, is certainly a non-reliable process; and, as the following facts will show, falls, in the case before us, far below the truth.

Sandstone pebbles occur in the conglomerates in various localities, and are especially numerous near the northern end of Teignmouth bridge. They have all the characters of neighbouring beds of New Red Sandstone, from which they were undoubtedly derived. Their presence indicates the following succession of events:—Prior to the formation of the *Conglomerate* strata in which the pebbles are found, *Triassic Sandstone* beds had been deposited and become coherent; sedimentation was then suspended for a time, and the area was abandoned to denudation, which tore down or unbuilt some of the arenaceous layers. Fragments of these destroyed layers then passed under the abrading action of the waves, by which many of them were reduced to sand, whilst others were simply more or less rounded; constructive operations having recommenced, these rounded masses, with fragments of much older rocks, were built into a new, a conglomerate story of the Triassic structure.

Judging from their characters, it seems impossible that any of the pre-triassic sandstones of Devonshire could have furnished the nodules in question; the following fact, however,

is conclusive on the point now contended for. Amongst the so-called new *red* sandstones there are beds which have been appropriately termed "*variegated;*" that is to say, beds in which yellow and other light colours alternate with the prevalent red. The phenomenon is very common, and is seen in Torbay and elsewhere. Now, I some time since detected in the conglomerates of Roundham Head, in Torbay, a fragment evidently derived from one of the variegated beds. I conclude, therefore, that in the rocks themselves we have evidence that they were slowly formed, and that the process of formation was sometimes not only intermitted, but exchanged for that of destruction.

Nor does this conclusion rest on the sandstone pebbles only; the confirmative evidence of denudational inequalities in the superior surfaces of beds, at various levels in the same section, is producible. Several examples of it occur in Torbay; but I will confine myself to the following. At a low point of land immediately south of Paignton harbour, the upper part of the cliff consists of a coarse conglomerate of a purplish-red colour; the lower part is made up of sandstone and fine conglomerate, with occasionally a thin layer of marl, and is of a brick-red with a few interstratified yellow layers. The phenomenon to which I wish to call attention occurs at the junction of the two sets of beds; consisting, in fact, of the character of the upper surface of the lower series. The entire section—the upper and lower divisions—is made up of beds having the same *dip* throughout, namely, about 11° towards N. 28° E. (magnetic); but it is a *non-sequent* conformability. (See fig. I.) Stripping off, in imagination, the upper or coarse conglomerate beds, beginning at the eastern or sea-ward end of the section, and proceeding west, or landward, we have a red sandstone surface or floor about twenty-four feet long; here we meet the first (1) of eight ascensive steps; it consists of one bed of red sandstone about twelve inches thick, the upper surface of which exhibits considerable denudational inequalities until, at nine feet farther west, the second step (2) occurs: this is the truncated end of a bed of mottled sandstone, about twelve inches thick. Two feet onwards from this is the third step (3), which is about eight inches high, and consists of two layers; the lower (variegated sandstone) six inches thick, the upper (red marl) about two inches. The fourth step (4), seventeen feet farther in the same direction, is about nine inches high, and is composed of two layers of yellow sandstone, measuring together about three inches; and four layers of red marl having an aggregate

thickness of six inches. Eight feet farther bring us to the fifth step (5), which is made up of three layers of yellow sandstone with two thin partings of red marl, the whole being about twelve inches thick. The sixth step (6) occurs at about a foot and a half farther west; it is nine inches high, and formed of one layer of yellow sandstone with two of red marl, each measuring about three inches. Two feet from this is the seventh step (7), which consists of four layers, and is fourteen inches high; namely, yellow sandstone three inches, red marl one inch, yellow sandstone eight inches, and red marl two inches. Between this and the last, or eighth step (8), which occurs at twenty-one feet from the seventh, the denuded surface is inclined to the horizon at an angle slightly higher than that of the *dip* of the deposit, so that four slender layers thin out to feather edges. The last step is a layer of red sandstone—the uppermost of the lower series—about eighteen inches thick, and having its upper surface worn into considerable inequalities. Over the whole lie the upper or coarse conglomerates, the base of which is a pavement of large nodules. Though this natural staircase is irregular, both in its *rise* and in its *tread*, and especially in the latter, the *tread* of each stair, with the exception of the first and two last, is, at least, sensibly a plane of stratification.

The history of the section just described is probably as follows: Every bed in it is eminently detrital; the earliest of them takes us back to a period when some more ancient rocks were being broken up and their fragments triturated. Having been thus prepared, the materials were carried to, and deposited on, the area which they now occupy. This work of denudation, trituration, transportation, and deposition went on for a lengthened period, until the lower series was completed; not, however, without periods of intermittence or change of conditions; the first being evidenced by the division of the accumulation into distinct and separable beds, and the second by the interstratification of materials so dissimilar as conglomerates, sandstones, and marls, and also by the alternations of red and yellow colours. That the whole, moreover, was tranquilly deposited on a tidal strand is indicated by numerous ripple-marks, as well as by the sun-cracks already mentioned.

The constructive processes were then suspended, and destruction followed.

Whether the two periods thus represented were separated by one of quiescence cannot be determined; the record is apparently silent on that point. Nor is there anything to

show whether that which is now the uppermost layer of the lowest division was originally so or not. Waiving these points, we may, without doubt, assume that all the *short* beds —all the successive steps—formerly extended to at least the eastern end of the section, and, when formed, were below the high water level.

It may not be, it probably is not, possible to say why the waves began now to tear down what they had previously built up; the fact that they did so is patent. They first destroyed the uppermost red sandstone bed back to the point where we now find the eighth step, and then, abandoning it, attacked the thin bands next below until the seventh step was completed; they next proceeded to a still lower level, and, by a similar process, chiselled out the sixth; and so on to the lowest. This successively operating on lower and still lower beds suggests the probability of a secular elevation of the district, by which the work, as soon as completed, was raised beyond the reach of the agents which had produced it.

At length the unbuilding was stayed and construction resumed, but the conditions were changed; instead of finely-comminuted sand and pulpy mud, coarse materials and boulders were next thrown down.

Before, however, leaving the denudation just described, there are three points which seem worthy of attention. The destruction, though emphatic and decided, appears to have been effected by a gradual and, so to speak, tranquil process. The materials are such as would have been readily furrowed under violent action, but, with very few exceptions, they have no inequalities; they do not appear to have been roughly handled; they bear no impress of violence. The forces which partially tore them down were powerful, but it was through the lengthened duration of their action.

Again, had the work of denudation gone on until the beds had been completely, instead of partially, removed, we should have been without a scrap of evidence that it had ever taken place. The *dip* of the overlying conglomerates is precisely the same, both in amount and direction, as in the beds beneath. We should have merely seen—what we do see repeatedly in the South Devon sections—a series of sandstone beds succeeded conformably by a set of coarse conglomerates, without the remotest indication of a chronological interval between them, save such only as we may be inclined to attach to the different conditions which produced strata so dissimilar. Yet, in the case before us, thanks to the fragmentary beds left to tell the tale, we know there were certainly two, and

possibly three or more intervening periods; namely, the period in which the beds were built up, that in which they were torn down, and perhaps one, or even two, of quiescence or inactivity.

Farther, a bed of the same volume is not necessarily of as great chronological value in the upper as in the lower series. The materials in the former were not so elaborately wrought, nor so carefully sorted; they were thrown coarse and fine together also, as if in a hurry; yet there were pauses in the work, for the mass resolves itself into well-marked beds: it is distinctly stratified, and the pebbles lie with their longest axes in the plane of stratification.

The structure known to geologists as "false," or "diagonal stratification," sometimes also termed "drift-bedding," is common in the sandstones, and many of the facts connected with it appear to be explicable only on the hypothesis of changes of conditions and the lapse of a large amount of time. Here again I will content myself with a single example, and will select one by no means of great complication. Near the base of the north cliff at Goodrington Sands, Torbay, there is a bed of red sandstone, about seventeen feet thick, and of very considerable horizontal extension. (See fig. II.) The section has an east and west bearing, and, assuming the former to be the exact direction of the *dip*, the inclination of the bed is 10°. This stratum resolves itself into three portions, distinguished by the *dips* of the diagonal layers or stratula. In the first (1) and third (3), that is the lowest and highest, the *dips* are the same, namely, 21° towards the west; whilst in the second (2) or middle portion it is 23° towards the east. The grains of sand are very small, and each stratulum is so thin as to be apparently one grain thick only; hence the water, which transported them so far, but no farther, must have moved with but little velocity. The separability of the stratula, too, seems to mark pauses in the work of building up. It is obvious, moreover, that each of the three divisions is a remnant only, and apparently a small one, of a more considerable accumulation.

The lowest portion (1) must have been formed by water flowing from east to west, and throwing down grains of sand on a declivity of 31° (= 21, dip of stratula + 10°, dip of stratum in the opposite direction); that is, assuming the bed to have been originally horizontal. Now, the least reflection will show that the stratula were successively formed by grains of sand thrown over the edge of a scarp, the level of which necessarily limited the height attainable by each layer;

hence, whatever the elevation of the highest existing summit (*a*), that, at least, was the height of every portion of the mass on the *east* of such vertex, or, speaking generally, on that side of it whence the sand was transported; and if, as is the case in the section before us, instead of at present maintaining this level, the upper surface (*a*, *c*,) of the eastern part of the mass dip in a direction opposite to that of transportation, the fact can be explained only by supposing denudation to have planed off the missing portion down to the slope *a*, *c*. It will be seen also that this by no means renders it certain that nothing more was removed. The vertex spoken of may originally have had a much more westerly, and also a more elevated situation; and, indeed, we shall presently see that this must have been the case.

The second portion (2) of the bed was formed in the same manner as the first, and of similar materials; the only differences being that the direction of transportation was reversed, and the dip of the stratula was less, being, instead of 31°, no more than 13° (= 23°, existing dip of stratula—10°, dip of stratum in the same direction). From the principle previously laid down, it follows that the scarp, over the edge of which the sand grains were drifted, must, at least, have reached a height equal to that of the vertex *e*; now, this applies to every stratulum in the mass, and therefore to the lowest, so that we must suppose this mass (2) originally extended back or westward until the stratulum *c*, *a*, produced in that direction, reached the level of *e* at least; but the scarp thus required for the formation of the lowest stratulum of the second portion (2) of the bed, must have consisted of a part, now destroyed, of the first portion (1); so that this lowest or earliest portion originally attained an elevation greater than that of its present vertex *a*; in fact, it must have reached the level of *e*, and maintained it also to some distance beyond, or west of the point *a*. Hence, as was formerly stated, the denudation must have been considerably greater than at first sight appeared; but, however great, it must have been completed before the deposition of the second portion (2) of the bed.

By parity of reasoning, it can be shown that the second portion (2) is but a fragment of a mass which was built up of matter transported from the west, originally reached the level of *d*, and was continued, at that or a greater height, eastward to or beyond *e*; so that in order to the formation of the slope, *e*, *a*, *b*, on which the third portion (3) of the bed was deposited, a mass must have been planed off which

occupied this slope as a basis, everywhere attained the level, at least, of *d*, extended, both east and west, far beyond that fraction of the section here considered, and consisted of parts of the first (1) and second (2) portions of the bed.

After the completion of this denudation, the deposition of the third part (3) of the bed was begun.

It may be of service briefly to recapitulate the succession of events recorded in this section:—

1st. A current of water moved gently from east to west, drifted along fine grains of sand, and threw them down a scarp where they formed layers or stratula, which, by their separability, mark pauses in the deposition, and, by their symmetry, indicate uniform, gentle, and gradual action. The layers were inclined towards the west at an angle of 31°.

2nd. A reversal of the direction of the water-flow accompanied by somewhat increased velocity, so as to enable it to tear up and remove much of the matter deposited by the earlier, gentler, and antagonistic current.

3rd. A diminution of the velocity of the current, which still moved from west to east, by which it was converted from a destructive to a constructive agent, and enabled to add considerably to the mass of the bed. The materials and structure were the same as in the former case, with the exception of the *dip* of the stratula being towards the *east* at the smaller angle of 13°.

4th. Again a reversal in the direction, and an increase in the velocity, of the stream, so as to produce a large amount of denudation of *both* the masses which had been deposited.

5th. This denudation was, as before, and in the same way, followed by sedimentation, the transportation being from east to west; the mode of building was still that of "diagonal stratification," but the *dip* was, both in amount and direction, the same as in the *first* instance.

Facts such as these can be paralleled in numberless instances in Devonshire, and frequently surpassed in complexity and eventfulness. They show not only the slow manner in which the red rocks were formed, but also the, probably, more important fact that the volume of a rock is by no means a measure of the amount of work or time expended in rearing it; and they are calculated greatly to enhance our estimate of the value of the units of geological chronology.

The general character of the *Conglomerates* is that of a mixture of entirely unsorted, coarse and fine materials, deposited together without the least reference to their relative

gravities; nevertheless, they are most distinctly stratified, and cannot be referred to any form of ice action; in fact, they constitute such an accumulation as would be thrown up by the waves on an *open* beach, and this applies to every layer in their enormous thickness; they are all of littoral origin, various as their levels are.

Again, the *Sandstone* and *Marls* are replete with fossil ripple-marks, sun-cracks, and impressions of rain-drops; they, too, were certainly formed on a tidal strand.

Now, the conclusions to which we have thus been led are explicable only on the hypothesis that the area on which the red rocks were deposited was one of subsidence, and that the downward movement must have been slow, is manifest from the fact, that the phenomena just described are discoverable in every layer. Enormous as their aggregate thickness is—sometimes amounting to several hundred feet in the same vertical line—the water was shallow from first to last; the foundations sank no faster than the structure was reared. It seems impossible to accept this conclusion without accepting also the idea that the time of formation was immeasurably great.

The *Devonian* slates and limestones of the Torbay district are traversed by, at least, two systems of joints, one having a direction nearly coincident with the magnetic meridian, the other not far from true east and west. For simplicity sake, I shall call the first "north-and-south," and the second, "east-and-west" joints.

Some of these joints—of each system—are "close;" that is, they have their walls in sensible contact, whilst others are "open," or have their walls separated by a greater or less interval, which may be unoccupied, or, as is most commonly the case, filled with extraneous matter.

Now, many of the latter kind are occupied with veins and dikes of fine Triassic sandstone, and this, in many cases, at considerable distances from existing new red sandstone beds; hence they furnish a proof that the red rocks have suffered considerable denudation and loss of area, and, what is more important for our present purpose, that the joints of the *Devonian* rocks were in existence, and some of them open, during, but, as we shall see, not necessarily before the Triassic period. A careful study of these dikes shows, as may be well seen between Brixham harbour and Berry Head (see fig. III.), that those filling the north-and-south joints (3), invariably intersect those running east and west (2); hence the latter are certainly more ancient than the former. As a farther

indication of their different ages, the north-and-south are of a darker colour than the east-and-west dikes.

The succession of events appears to have been as follows:—

1. The open east-and-west joints in the *Devonian* rocks were filled with red sand during an early portion of that division of the Triassic period which is represented by the red rocks of Devonshire.

2. After these east-and-west sand dikes had become quite coherent, the north-and-south joints, which pass through them as well as through the Devonian rocks, were formed.

3. Waiving the question whether any of these last joints were likely to have been close when first formed, such of them as were open were also filled with red sand during the period of the Torbay Trias.

This is the reading of a *vertical* section: it is more than confirmed by the study of the ground plan or horizontal section of the same dikes (see fig. IV.), for it is then seen that those having an east and west direction were not only jointed, but "*faulted*" also, before the formation of those running north and south. We have thus a second and, perhaps, more emphatic proof that the sandy material of which the first dikes are composed had become perfectly coherent prior to the formation of the second joints; in other words, the intervention of a considerable period is here indicated—a period, however, which was necessarily a small fraction of that represented by the red rocks of South Devon.

The following points are, perhaps, worthy of remark:—

1. For anything that has been shown, the east-and-west dikes may, or may not, represent the very commencement of the Devonshire Trias; they may, or may not, have been coeval with the first stratum of the formation.

2. The acquisition of a stable cohesion by the first dikes, may, or may not, have been immediately followed by the formation of the north-and-south joints.

3. The faulting and jointing of the earliest dikes may, or may not, have been separated by an interval of time.

4. An unrepresented interval, in either of these cases, would, of course, enhance the chronological value of the phenomena now under discussion.

So far as can at present be seen, the record is silent on the first and third points, but it affords the most conclusive evidence that a period did intervene in the case of the second. That the second series of joints did not come into existence as soon as the first system of dikes had acquired a durable cohesion, is seen in the fact that longitudinal veins of car-

bonate of lime occur in the relatively ancient (2), but not in the modern (3) dikes. (fig. IV.) They come up on each side to the walls of the latter, where they are sharply cut off, and they are faulted in the same manner as the dikes in which they occur. Now, these veins are simply fissures which were formed after the dikes containing them had become coherent, and then filled by the gradual precipitation of carbonate of lime, before the formation of the north-and-south joints which severed them.

We are now enabled to trace the progress of events somewhat in detail:

1. The filling in the east-and-west open joints with red sand, at a period not earlier than, if so early as the commencement of the Torbay Trias.
2. The induration of this sand into coherent and durable dikes capable of being fissured and faulted without their sides falling in.
3. The formation of longitudinal fissures in the dikes.
4. The gradual filling up of these fissures, not with sand, but by the precipitation of carbonate of lime.
5. The formation of transverse joints, passing, in a north and south direction, alike through the Triassic dikes and veins, and the pre-Triassic rocks.
6. The faulting the entire mass—rocks, dikes, and veins—by inequalities of movement in an approximately horizontal direction.
7. The filling in of the north-and-south open joints with red sand, as in the first instance, so as to form dikes passing through those previously existing. The two systems being distinguishable by well-defined walls and a marked difference of colours.

All the events here detailed occurred not only within the era of the Torbay Trias, but apparently within its *Sandstone* division, since there are no indications of either the Conglomerate or Marl—both largely represented in the red rocks of the district.

The facts described in this paper appear to me to show conclusively that the rocks in which they occur are the exponents of a lapse of ages great beyond human conception; and now, in conclusion, let us reflect for one moment on the relation which these rocks bear to the entire sedimentary series, thus omitting all consideration of the still older rocks which are essential to the existence of the earliest layer of sediment.

The geologist divides the sedimentary rocks into four

great groups of systems—the Azoic, Palæozoic, Mesozoic, and Cænozoic. The red rocks of Devonshire belong to the Mesozoic group. This he subdivides into Triassic, Jurassic, and Cretaceous. The rocks we have been considering are assigned to the Triassic or lowest. This he again divides, as its name implies, into three divisions—Bunter, Muschelkalk, and Keuper. Our red strata, the accumulated deposits of untold ages, represent no more than, if as much as, one of these—the Bunter or the Keuper, probably the latter.

EXPLANATION OF THE FIGURES.

FIG. I. Is a vertical section of the cliff immediately south of Paignton Harbour, Torbay. (See page 34.)

L. Is the lower series, consisting of sandstone, fine conglomerate, and marl.

U. Is the upper series, made up of coarse conglomerate. The numerals (1 to 8) show the "eight ascensive steps."

Just so much only of the section is introduced into the figure as is required to show the junction of the two series; hence neither the base nor summit of the cliff is seen.

The beds, instead of being horizontal as they are here drawn, have an inclination of 11° towards N., 28° E.; but, in order to save space, this is omitted in the figure, since it was not necessary to the explication of the facts described in the text.

FIG. II. Is a vertical section of a bed of sandstone at the base of the north cliff at Goodrington Sands, Torbay, (see page 37,) in which "diagonal stratification" is well displayed.

The bed is 17 feet thick, and extends along the cliff for a considerable distance; but the figure includes no more of its length (about 33 feet) than is necessary to show the phenomena described in the text. On account of the *dip* of the bed, (about 10° towards the east), the entire thickness is shown only at the western end; the base of the figure being horizontal.

The numerals (1, 2, 3,) show the three portions of which the bed is made up. In the first and third the *dip* of the stratula is the same both in amount and direction, namely, 21° towards the west. In the second it is 23° towards the east.

FIG. III. Is a vertical section on the shore of Torbay, between Brixham and Berry Head. (See page 40.)

1. Is Devonian limestone in nearly horizontal strata.

2, 2. A vertical dike of Triassic sandstone, running east and west.

3, 3, 3, 3. Vertical dikes of Triassic sandstone, having a north and south direction, and intersecting both the limestone and east-and-west dike.

FIG. IV. Is a horizontal section, or bird's-eye view, showing the intersection and faulting of the east-and-west dike (2, 2, 2), by the two north and south dikes which are near the eastern end of fig. III. (See page 41.)

The former (2, 2, 2,) is, in this figure, coloured black in order the more easily to show, by the white lines, the veins of carbonate of lime which occupy them longitudinally.

ABSTRACT

OF

SOME REMARKS ON RECENT CONTROVERSIES

RESPECTING THE

ANTIQUITY OF THE HUMAN RACE.

BY THE REV. J. ERSKINE RISK, M.A.

Sir CHARLES LYELL, in his recent work, makes the following quotation from M. Agassiz:—"When a new and startling fact is brought to light in science, people first say it is not true; then that it is contrary to religion; and, lastly, that everybody knew it before." Sir Charles Lyell believes that, as regards "the cultivators of geology, the doctrine of the former co-existence of man with many extinct mammalia, has gone through these three phases in the progress of every scientific truth towards acceptance." He therefore kindly devotes his next three chapters "to laying the grounds of his belief before the general public." Since the publication of Lyell's work, however, and more particularly since the recent discovery of the human jaw-bone, which was supposed to supply the missing link in the chain of evidence which was otherwise declared so perfect, the unanimity among geologists has not been so complete as was supposed to be the case by Lyell and some of his collaborateurs. A veteran French geologist, of high reputation, M. Elie de Beaumont, has been found to maintain, in a full sitting of the French Academy in May last (1863), a somewhat singular opinion on this subject. When the question of the authenticity and age of the recently discovered Abbeville jaw was under consideration by the French *savans*, M. Elie de Beaumont produced no little sensation by expressing his opinion that the bed in which it was found was not diluvium, or even alluvium, but simply the *débris* of the neighbouring hills, washed down by one of those torrential rains which occur perhaps once in a thousand years. In confirmation of this opinion, M. de Beaumont laid

great stress on the state of the bone as contrasted with that of the elephant and rhinoceros bones found associated with the hatchets. He accounts for the juxtaposition of the bones of man and the extinct animals, so as not to be obliged to maintain their contemporaneity in the *terrains de transport*, as Lyell imagines all geologists now do. The hypothesis is, in M. de Beaumont's opinion, quite admissible, that the exceptional flood alluded to may have washed down the flint implements from the place of their manufacture; may have also swept along with it the bones from a neighbouring sepulchre; and, acting with even greater force than before, may have torn up from the diluvium, or lower soils, the fossil remains of *elephas primigenius;* and other extinct animals. It is somewhat remarkable that M. de Beaumont's geological maps of 1855 mark those Abbeville beds as being of the character now maintained by M. de Beaumont. It is not surprising, therefore, that he considers the Abbeville jaw not to be that of a fossil man at all, but simply of a savage of the so-called stone age. At the same meeting of the French Academy, M. Robert, another French *savan*, gave an interesting explanation of those marks on specimens of fossil ivory which had been supposed to prove the contemporaneity of man with the extinct animals. When the Celts were making hatchets of the stones washed down by the Somme, or other rivers, they, he thinks, doubtless often met with tusks of fossil ivory, washed out of the real diluvium. They would, of course, find they could make no use of the ivory from the changes which had taken place in its structure; and for the same reason, the bones of the great pachyderms would be thrown away after trying to hew them into shape with their stone hatchets. It is true that, at a subsequent meeting of the Geological Society, Mr. Prestwich is reported to have admirably disposed of these opinions of M. de Beaumont *seriatim*, and to have proved that the deposit belonged to the *high level gravels*, *apparently* "to the satisfaction of those *best capable of forming an opinion*." Not having those arguments now before me, I cannot, of course, speak as to their force; and yet in spite of the high antiquity which Mr. Prestwich thus claims for the deposit, it seems that Mr. Prestwich still considers the jaw may be genuine. He quite concedes the suspicious circumstances connected with the discovery, and particularly the present abundance of flint implements of one kind where formerly flint implements were but *seldom* found, and those of *another* character; and yet, so strong is his disposition to believe, that he asserts, and even maintains, that the apparent

spuriousness of the flints might arise from our present ignorance of their real characteristics. Surely, this is the argument *ex ignorantia* with a vengeance. Have we not, however, in recent controversies, often met with a similar line of proof? Have not many been found to maintain, that because, for aught we know, a thing *may* be, we have a right to presume that it *is* in existence? Would not the wiser course have been to affirm or deny nothing till the point in question is either proved or disproved? At the same meeting of the Geological Society, it was ably argued by Professor Busk, that the "jaw-bone of contention" belonged to the stone age—an opinion in which he not only corroborates M. de Beaumont, but is himself corroborated by M. Pruner Bey, the celebrated French anthropologist. There was a very strong general impression among the geologists assembled at the time, respecting the dishonesty of the workmen at Moulin-quignon. Professor Busk was quite of opinion that the jaw was of the same age, and possessed of the same peculiarities, as were two skeletons previously discovered by M. Boucher de Perthes, which indubitably belonged to the stone age. Now, the workman who brought these skeletons to M. Boucher de Perthes has been found out in two unmistakeable forgeries, and it is hinted that the jaw may have found its way into the deposit from his stores. All that can be said by the French *savans*, who quite believe in it, is, that M. de Perthes saw it lying, as he thought, *in situ*, with the surrounding gravel apparently undisturbed. The flints found associated with the jaw are notoriously destitute of the dendritic markings, and other indications supposed to characterise the genuine flint implements, the fractures being deeply conchoidal. It was for these reasons that Dr. Falconer decided against their genuineness, as well as that of the jaw, though subsequently somewhat influenced by Mr. Prestwich's strong expression of opinion. I am glad, however, to find that Dr. Falconer and Professor Huxley are quite agreed upon one point which the whole discussion has now brought into marked prominence, viz., the value of internal evidence as compared with that of testimony. The testimony is here all on one side—the evidence on the other. The French *savans* at Abbeville believe the former—the English geologists in London, the latter.

"Who can decide when doctors disagree?"

Quatrefages, Desnoyers, Milne-Edwards, Lartet, and others, affirm—Falconer, Busk, Evans, and others, deny. In fact,

the history of this discussion respecting the authenticity and age of the Moulin Quignon jaw is so amusing, that I have thought it might not be out of place to contrast a few of the statements which have appeared on the subject within the last few months. On the 25th April, we read in a certain periodical, "The human jaw, fossil or otherwise, which M. Boucher de Perthes has discovered in the very oldest portion of the gravel beds . . . . is pronounced by many . . . . of our geologists best able to form an opinion, to be one of the best attempts at imposition on record." "There is a difficulty about the jaw which is very remarkable. Anatomists who have examined it declare it to be a jaw of the Papuan type! Others affirm, indeed, it may be a royal jaw, unearthed from an ancient sepulchre, hard by, of the Merovingian kings." What a compliment to royalty! On the 2nd May we are informed "that the remarks made the previous week were too well founded," and in spite of the glowing statements of M. Quatrefages and Dr. Carpenter, Dr. Falconer, supported by the opinions of Messrs. Prestwich, Evans, Busk, and Somes, has declared that the whole affair—flints, molar, and jaw—was a clever imposition practised by the *terrassiers* of the Abbeville gravel pits; so cunningly clever, that it could not have been surpassed by a committee of anthropologists enacting a practical joke. But M. Quatrefages rejoins—"This jaw has, perhaps, chewed the tough flesh of *elephas primigenius*, and *rhinoceros tichorhinos*, and I consider it," he adds, 'to be the jaw of a female.'" Mr. Somes, however, steps in, and mercilessly overthrows a bushel of theories, by simply matching the jaw, peculiarities and all, including molar in section, fresh, gelatinous, and glistening, from a London graveyard! A similar verdict of doubt is recorded on the 16th, as the result of a conference at the Jardin des Plantes, when Sir John Bowring was present. On the 30th, the meeting of the French Academy is recorded with the opinions of M. de Beaumont and M. Robert, in opposition to the fossil character of the jaw; while, on the 23rd, we had been gravely assured that "the Abbeville jaw, found on the 28th March, is now recognised to be a genuine fossil."* Such is the decision of the French *savans*, assisted, it is said, by certain English assessors. But, alas! for the uncertainty of the conclusions of maxillary science! Shortly after, the Geological Society meets early in June, and the decision is for a new trial of this *cause célèbre*. Dr. Falconer, who had been present at the

* *Procès verbal* at Abbeville.

French trial, and reserved his opinion on every point but that of the authenticity of the jaw, now regrets he had not reserved that point also. In spite of the precautions of M. Milne Edwards at Moulin Quignon to prevent tampering with the gravel pits, not one of the five hatchets found there on the day of the visit was discovered *in situ;* and what seems still more extraordinary, not one of these was critically examined till the close of the day. I think, then, that we in England can well afford to decide the question on the internal evidence which has weighed so much with English judges, rather than on the testimony which, shaky as it was, has been relied so much upon by the French.

It is not, perhaps, every one who can at first discover the extreme importance of carefully testing every alleged instance of a newly discovered ancient, or, still more, of a fossil skull. There are some persons on the look out for such discoveries. It is their belief that such skulls must necessarily be of a different type from those at present existing. Hence, the Moulin Quignon jawbone was styled Papuan, or peculiar—anything, in short, but modern-like—till Mr. Somes produced its fellow from a London graveyard. Even the Neanderthal skull, of which so much has been made, as affording a possibly intermediate type between the man and brute, has been shown by Professor Busk to be quite capable of being matched by the skulls of individuals of European race. Sir Charles Lyell himself admits that this observation has since been fully borne out by measurements. The fact is, that notwithstanding the apparent similarity of structure of the skulls and brains of some men and some apes, there is a vast chasm between them which has never been bridged over, and which never will, let the advocates of Natural Selection say what they may. This point is so well brought out in some remarks on a lecture of Mr. Gore's, made by Professor Owen on the 7th April last, before the Anthropological Society, that I cannot forbear a further reference to it. Mr. Gore's lecture was "On the brain of a microcephalic female idiot," which only weighed ten ounces, the skull, also, being very diminutive. Speaking of the skull, Professor Owen put the possible case of an idiot, with a similar imperfect brain, wandering into a cave; dying there; becoming covered with mud, or imbedded in stalagmite, so that, when discovered, the skull might be trumpeted abroad as presenting the long missing link between man and the lower creation. And yet, in the Professor's opinion, the brain of such an idiot would be seen to be widely different from that of the anthropoid apes. And

if so, the difference is too wide to be bridged over by any skull of the inferior animals yet discovered.*

I have now a word or two to say respecting the co-existence of human remains and the flint knives, if such should ever be proved to be the fact.† Whatever may finally be established concerning an antiquity of the human race, which would add, not a few thousand years, which many might admit, but an untold number of ages, which as many would deny, to the present popular chronology, there is one thing which should not be lost sight of in the argument. The fact to which I allude is one which has only recently been brought under my own notice. It is this. Flint knives were used among the early nations of the world, and when used, appear to have been buried in the sepulchres of their great men. It is well known that the Jews used flint knives in the rite of circumcision; but it is not so well known that they disposed of their flint knives in the way just mentioned. There is a remarkable addition to the Scriptural account of the burial of Joshua given in the Septuagint version. (Joshua xxiv. 30.) It is as follows:—"They placed with him in his tomb the flint knives with which he had circumcised the children of Israel...... and there they are to this day." It would not, therefore, be a very strange thing to find flint knives associated with human bones in tumuli on the ridges of hill tops, with caverns beneath, or even in those caverns. The Welsh, themselves a Celtic people, are said to have used flint knives for sacred purposes, though well acquainted with the use of iron. I am reminded, by this reference to the use of flint as well as iron by the old Celtic races, that I cannot close without touching on the distinction instituted by modern Danish and German archæologists between the ages of antiquity into the stone, bronze, and iron. I do not consider it to be absolutely well founded,

* For a very amusing sketch of what a purely animal man of the fossil type may be supposed to have been, see *L'Homme Fossile*. By M. Boitard. (pp. 245, 249.) Paris: Passard, Libraire—Editeur. 1862.

† While these papers were passing through the press, a very interesting letter of Dr. Falconer, in the *Times* of March 25th, 1864, announced the discovery, by M. Lartet and Mr. Henry Christy, in the caves of Dordogne in France, and elsewhere, of human bones and implements in association with the remains of extinct animals. But, as upon the weapons, which are made of reindeer horns, representations of animals are elaborately carved, the period must be more modern than the cave theories would appear to maintain. The artistic skill of the carving too would seem to demonstrate the employment of bronze, if not of iron, tools—and not of delicately-pointed flint flakes, which is Dr. Falconer's supposition.

though it is very convenient for purposes of nomenclature, and may be adopted when not intended to denote the historical succession of events. It was invented, I believe, to express what some archæologists fancied to be an historical fact, simply because of the absence of iron in many places where flint tools are now met with. But you will easily see that this proves nothing. Iron is one of the most perishable of metals; it gradually dissolves away in water, and in salt water has been found to change its structure considerably, as some of our late iron ships can testify. Those who believe that the non-appearance of human bones in the earlier formations is easily accounted for from the superior dissolvability of the human structure, as compared with that of other animals, must, I am sure, see the force of this argument. It is, in fine, at least as likely, if we argue from probabilities only, that man started from a high state of knowledge and art, to lose it for a time, and then recover it, as that he set out from a state of crass and stolid ignorance to grow to a degree of skill and intelligence, "widening with the process of the suns."

E. Vivian, M.A., M.B.M.S., gave some statistics of the Meteorology in South Devon, and exhibited his newly-invented self-registering hygrometers.

ON SOME RECENT ADDITIONS TO THE FAUNA OF DEVON.

BY J. BROOKING ROWE, F.L.S.

[*Abstract.*]

THE following species were referred to as having occurred in the county, and not recorded, except in periodicals.

AVES.

Aquila nævia. Briss. Spotted eagle. One specimen was killed at Lundy Island in 1859.

Regulus ignicapillus. Brhm. Fire-crested Regulus. Two have been obtained in the county,—at Devonport.

Accentor alpinus. Gmel. Alpine Accentor. Specimens have been observed at Torquay and Plymouth.

Aëdon galactodes. Temm. Rufous Sedge Warbler. This Continental warbler has only been noticed twice in this country. The first on Brighton Downs, in 1854, and the second near the Start Point, in 1859.

Calamoherpe turdoides. Meyer. Thrush-like Warbler. Eggs of this rare British species have been taken from the nest at Staddiscombe, near Plymouth.

Melanocorypha calandra. Linn. Calandra Lark. Mr. Gatcombe recently found, in the collection of a bird preserver at Devonport, a bird of this species, which had been obtained in the neighbourhood, and was supposed by its possessor to be a specimen of the Shore Lark. This is the only specimen recorded as British.

Syrrhaptes paradoxus. Pall. Pallas' Sand Grouse. Two of these birds were shot out of a flock of thirteen, seen on Slapton Ley, near Kingsbridge, in June, 1863.

Cursorius europæus. Lath. Cream-coloured Courser. A pair were seen on Braunton Burrows, North Devon, in 1860, by Mr. Matthews.

Anser canadensis. Linn. Canada Goose. Four specimens, apparently wild birds, have been obtained in this county. The two last, in the winter of 1860.

Chroicocephalus ichthyaëtos. Pall. Great Black-headed Gull. One of these birds, the giant of the Black-headed Gulls, was shot near Exmouth in June, 1859, the only instance of its occurrence in England.

AMPHIBIA.

Triton palmatus. Dum. et Bib. Palmated Smooth Newt. This species is not uncommon in many localities.

N.B.—The above-mentioned species have all been more particularly mentioned in my recently published "Catalogue of the Mammals, Birds, &c., of Devon."

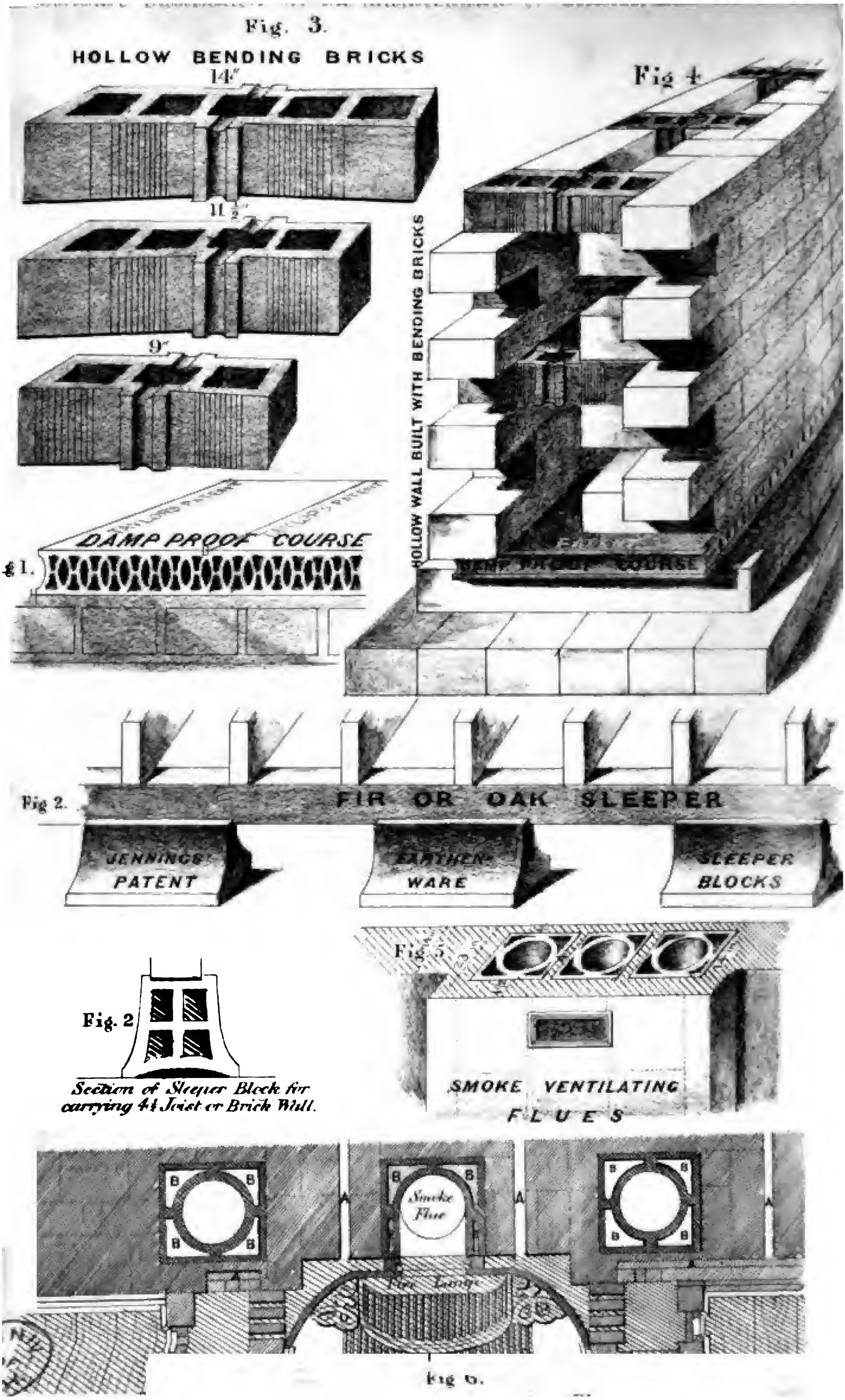


Fig. 3.
HOLLOW BENDING BRICKS
14"
11½"
9"
Fig 4
HOLLOW WALL BUILT WITH BENDING BRICKS
DAMP PROOF COURSE
DAMP PROOF COURSE
Fig 1.
Fig 2.
FIR OR OAK SLEEPER
JENNINGS' PATENT
EARTHEN-WARE
SLEEPER BLOCKS
Fig. 2
Section of Sleeper Block for carrying 4½ Joist or Brick Wall.
Fig 5
SMOKE VENTILATING FLUES
Smoke Flue
Fire Range
Fig 6.

OUR HOMES.

BY EDWARD APPLETON, F.I.B.A. Assoc. Inst. C.E.

[*Abstract.*]

. . . . Every Englishman's house may be his castle in one sense, but every man is bound, by the laws of humanity, and in justice to himself, his family, his domestics (if he have them), and society at large, to take care that his castle is a healthy one.

I propose in this paper very briefly and concisely to show a few ways in which the ordinary dwellings of the present day may be improved and made more healthy . . . . . .

We have hitherto, I think, paid far too little attention to the importance and advantages of what may be called *the hollow system of construction*, which, for Englishmen, is greatly to be wondered at, as, apart from the *sanitary* view of the subject, a very little argument is needed to show its *economy*. I shall have occasion in this paper to point out several details of *hollow* construction which may be advantageously adopted in every dwelling.

Commencing with the *foundations*. Nothing can be of greater importance in building a house than to secure a *dry* as well as firm foundation; in fact it is now universally admitted that warmth and dryness are two great *essentials* of a healthy dwelling. And yet, in the present day, $\frac{80}{100}$ of the houses erected have *no* means whatever adopted in their original construction to prevent the absorption of damp through the foundations . . . .

The use of slate, bedded in cement, asphalte, sheet lead, or layers of tar and sand, placed in the walls *below* the lowest floor level is frequently found an efficient means of preventing

the rising of damps by capillary attraction; but no house ought to be without *a dry area, well ventilated and drained*, to prevent the walls coming in contact with the surrounding earth. The best plan, however, which I have yet seen to prevent the absorption of damp through foundations is "Taylor's Patent Damp-proof Course." (Fig. 1.) It is composed of *glazed stoneware*, perforated horizontally, and it is impossible to conceive that it would allow the passage of damp, apart from the impervious nature of the material itself. The cost will be found to be no more than asphalte. At first sight these slabs may appear to be too slight to bear the superincumbent weight of a lofty house; but there need be no fear on this score, for they have been tested equal to the pressure of a vertical column of brickwork six hundred feet in height. Another advantage gained by the use of these slabs is the securing of *ventilation* to the basement story, or ground floors where there is no basement; and this would prevent the disagreeable, mouldy, musty smells so often experienced in many houses having no basement story, and would also keep away the great enemy 'dry rot.' . . . .
While engaged upon the subject of foundations, I am anxious to call your attention to another simple but exceedingly valuable article, introduced a short time since by that indefatigable sanitary worker Mr. Geo. Jennings, whose many admirable inventions are well worthy the examination and adoption of every one engaged in building operations. We shall have occasion to refer to some of them again in the course of these notes.

It is usual to secure the joists of rooms on the ground level (where there are no basements) to pieces of timber termed *sleepers*, bedded in mortar, on walls raised a few inches from the ground; it will be readily understood, that the same arguments as to the evil of not guarding against capillary attraction in the *main* walls of a house, apply also to these *floor* walls; careful construction on the old system, substituting cement for the mortar, and keeping the timbers at least 12 inches above the soil, with *thorough ventilation* for the space under the floors will, doubtless, under ordinary circumstances, keep the floors dry and sweet; but I think Jennings's *Sleeper Blocks* (Fig. 2), as they are termed, will at once commend themselves to every one, as meeting the requirements of the case *better* than floor walls, being hollow, and made of *vitrified* stoneware, all absorption by capillary attraction is entirely obviated. These sleeper blocks may also be advantageously used as the foundation for internal

partitions and walls, in which case they should be placed close together, or nearly so.

But we have not only to guard against damp, with its concomitant evil from below; we must next see how damp caused by the ordinary rain-drift on the surface of walls, may be kept out. The usual plans adopted are partially external, by the use of stuccos, cements, and paints; and partially internal, by battening and surface treatment; but, undoubtedly, if we seek a *dry dwelling,* we should not be satisfied with these skin-deep precautions, which are so easily and soon destroyed; if we can secure *an air space within the walls themselves,* (similar to that acquired by battening on the surface,) we shall accomplish our object, and prevent all damp penetrating through the walls. To do this, they must be built in two or more parts; viz., with an *outer* and *inner* face, leaving *the air space* between. We shall also gain another advantage by this space of air: the changes of temperature will be less perceptible within the house, we shall be warmer in winter, and cooler in summer, than with our walls built solid . . .; but a wall built in this way would be obviously very *weak;* to guard against this, Mr. Jennings proposes the use of *bonding* or *tying* bricks (Figs. 3 & 4), made of glazed stoneware, and themselves made hollow, with three sizes of these bricks; viz., nine, eleven-and-a-half, and fourteen inches long, walls of any thickness may be thoroughly bonded together. . . . . Another recommendation to this system of building is, as I have before said, its *economy;* it will be obvious to any one, that a large amount of material is saved, equal in the case of an ordinary fourteen inch wall to $\frac{2}{7}$, without any additional labour in building; for a bricklayer could certainly lay 1000 bricks on this plan, as quickly as on the old; and of course, if the material is saved, the labour of transmission to the building, and placing it on the walls is also saved; battening is also rendered unnecessary, and therefore an equal internal area is covered with less walling and roof. . . . .

I must next very briefly call your attention to the vexed question of ventilation. The basis of sound proper ventilation I take to be the securing of a sufficient supply of pure air, at a temperature which shall be healthful and agreeable for respiration, and the getting rid of respired air as speedily as possible; and these two essentials must be obtained without draught or other unpleasant effects. And such means only should be adopted, as are free from mechanical difficulties, unattended with great first or permanent expense; and

last, though not least, self-acting. . . . . Adopting the theory that air, when heated, becomes specifically lighter, and ascends, we must take care that, in whatever plan we adopt, we must first provide for the exit of the vitiated air, at as high a level as possible, and there endeavour to maintain or increase its temperature, in order to secure its complete egress.

The plan which I now wish to bring before your notice, I think meets all these requirements. First, let us see how we can get rid of the heated air; and then, how we can supply its place with fresh air at a proper temperature for respiration at all seasons. The combination of an air flue with the ordinary chimney seems the most natural means of securing a heated duct for leading off the vitiated air from an apartment; the question then arises, how best to accomplish this. The mere insertion of a metal air flue *within* the smoke chimney would be attended with considerable inconvenience and expense, and would greatly increase the trouble of sweeping the chimney; but if we invert this plan, and place the smoke flue within the air flue we get over the difficulty. Mr. Jennings (I believe) has again come to our assistance, and we have now a combined smoke and air flue in one piece. (Figs. 5 and 6.) The block is a hollow cube of stone-ware, with a cylinder inserted in it. The cylindrical portion forms the smoke flue, and the angles form flues for carrying off the vitiated air, the temperature of which is kept up, and even raised, by the passage of the smoke through the centre of the flue, and thus a continuous upward current is maintained. These blocks fit on to each other, and are built into the wall, with proper junction-pieces inserted near the ceiling-line of the apartments to be ventilated. . . . . . . But, as I before said, to secure perfect ventilation it is absolutely necessary to *provide* for the proper *ingress* of fresh pure air as well as the egress of foul air; and if this is not done we shall have complaints of draughts from windows and doors. And even if the windows and doors are so well made as to be draught-proof, or are rendered so by sandbags and other contrivances, the cold air will find access somewhere, and the probability is, it will find its way *down* the chimney flue, causing a smoky chimney; for a double current will be going on—an upward current of heated air and smoke, and a downward current of cold air, which will bring more or less of the former with it. And so with the ventilating blocks: if we do not *provide* for the *ingress* of air to the room, we shall find the cold air will come down the chimney or air flue, render-

ing both useless. We must therefore next consider the best plan of obtaining a supply of *fresh* air, but though fresh, not necessarily *cold.* . . . .

We said before that the fresh air should be of a temperature agreeable and healthful for respiration; and as it frequently happens, even in Devonshire, that in winter the external air is cooler than one would wish to breathe or feel, while sitting before a fire, means must be found by which the cold air may be warmed to a moderate temperature before entering the apartment. This may easily be accomplished by constructing air chambers at the back of the fire-place, into which the cold air must first pass, and there get warmed (fig. 6); and these chambers must have openings into the apartments to be ventilated. Experiments have proved that fresh air may be warmed to 60° with an ordinary fire on this plan, with the thermometer below freezing out of doors; and the rarifying of the air by the heated surfaces of those chambers causes a continual inward current to make good the place of the respired air being carried off by the flues, and feeding the fire with a proper amount of air, thus preventing a smoky chimney *and its accompaniment.*

There are many other points which one would wish to refer to, in dealing with this subject; but the space allotted to these papers renders it necessary at the present time to stop; we may have occasion to refer to it again at some future period.

MORPHOLOGY

IN PRIMULA VULGARIS PLENA-CARNEA.

BY EDWARD PARFITT.

[*Abstract.*]

THIS curious and interesting example of morphology was brought to my notice by Mr. W. Ellis; it was growing in his garden, Dec. 28th, 1862. The plants, from which the present example was obtained, had been divided a little time before, and planted about the garden; they had had just sufficient time to get hold of the earth, but not time enough to produce flowers, although vitality was not quite dormant.

Most if not all the other plants had living leaves on them, when they were removed and divided, except the one under consideration; this had one yellow or withered leaf, which was of little or no use to it; but it had, as will appear, a number of latent flower-buds, which in all probability would have remained in abeyance until the bright days of spring would have called them forth, had the plant had leaves to carry on its functions.

It would seem the plant had made an effort to supply the loss of its leaves by the development of the latent flower-buds, the whole of the vitality of the plant having been directed through this channel, the consequence of which was the abnormal slit of these flowers.

The first example, (as was shewn by drawings of the metamorphosed flowers,) was, that the calyx had been changed from its normal condition into small leaves of the same consistency as true leaves in a healthy plant. The neuration, too, had all the appearance of true foliage, but the flower remained in abeyance, the whole had become thoroughly charged with chlorophyll.

In the second example, the calyx had remained in nearly

its normal state, but here the flower had been changed; what should have been petals were turned into leaves having all the appearance of true leaves, with the neuration very distinct. In this flower was a group of slightly bi-lobed, pale, yellowish processes standing at the base of what should have been in the normal flower the placenta. Now, whether to regard these processes as parts of the divided placental column, with the apparent ovales attached, or whether they are conjugated metamorphosed anthers with their filaments much enlarged, I am at a loss to understand. Other examples were shown, but the present may suffice to show how nature had exerted herself to supply the loss which the plant had sustained.

ON THE

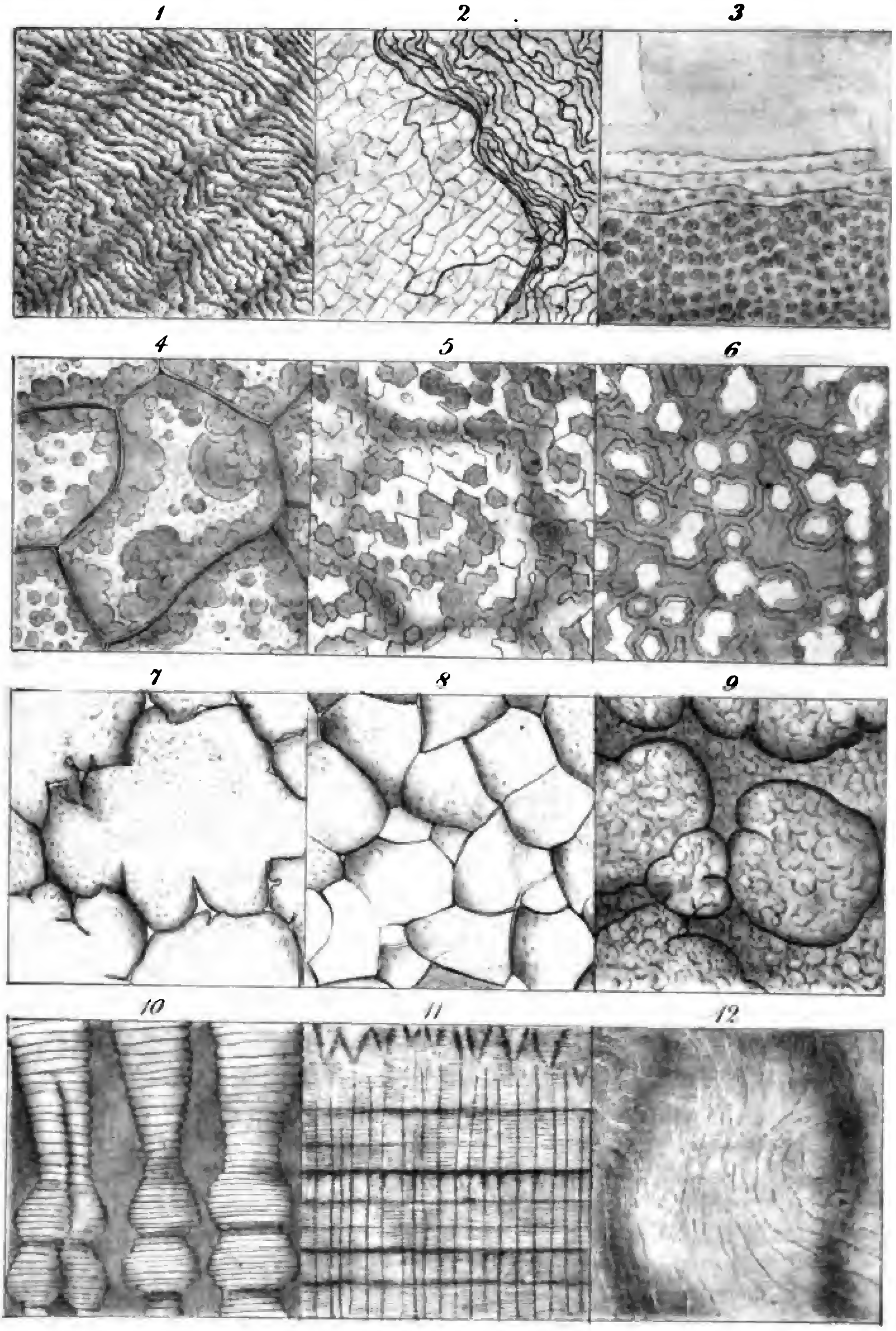
STRUCTURE AND CAUSE OF COLOUR IN THE NACREOUS LAYER OF SHELLS.

BY C. STEWART, M.R.C.S.

Believing that every fact, however apparently trivial, is worthy of being recorded, provided sufficient evidence of its truth can be adduced, I venture to bring before your notice a few observations on the structure and cause of colour in the nacreous layer of shells. This layer, commonly called "mother of pearl," is, as is well known, the innermost layer of the shell—the one last formed by the animal, and from whose beautiful iridescent tints its value as an article of commerce is derived.

The hypothesis originally propounded by Sir D. Brewster was, that this iridescent appearance was owing to minute striæ or grooves on the surface of the nacre, and that these striæ were caused by the out-cropping of laminæ of a calcareous nature that alternated with others of animal membrane. This view has since been modified by Dr. Carpenter, who holds that the striæ are caused by folds in a single membrane.

The arguments used by Sir D. Brewster in support of his hypothesis being, first, that after he had taken casts of the nacre in sealing-wax, these casts presented all the colours of the surface whence they had been taken, showing they were due to some surface-marking, either by grooves or striæ; and, secondly, the well known power possessed by regularly striated surfaces of producing a play of colour, such as those of Barton's buttons, Nobert's lines, &c. Whilst, however, examining some sections of shell, I could not help being struck with the great irregularity of the striæ of the nacre. Now, as the law for the production of colour by striated surfaces is, that the distance between the lines shall be a multiple of the length of the undulation of the colour reflected, it is evident that in this respect the observed fact of its structure does not agree with the law to which the cause of colour has been referred.



Maddock, Lithog.

IV.

Thousandths of an Inch.

Scale 1 2 3

Description of Plates.

No. 1. Section of Nacre of Avicula, showing its striation.

No. 2. Fragment of Nacre from Pinna, fractured in the direction of its laminæ on the left and obliquely to them on the right, the elementary particles are well seen.

No. 3. Decalcified laminæ of Nacre from Haliotis.

No. 4. Extremities of the Prisms of a Pinna, with early deposit of Nacre upon them.

No. 5. Hexagonal crystals, constituting the first deposited Nacre of Pinna.

No. 6. The same somewhat modified.

No. 7. Extremities of the Prisms of a Pinna, their sides having become inflected before the deposit of Nacre.

No. 8. The subdivision of the Prisms completed.

No. 9. Nacre deposited in a globular form.

No. 10. Vertical section of the Prismatic layer of a Pinna, the Prisms separated by a large amount of intes-prismatic substance, and having their elementary particles very evident.

No. 11. Vertical section of Nacre of Haliotis.

No. 12. Free surface of Nacre of Avicula.

This led me to suspect that the supposed casts really consisted of a thin film of nacre, adhering to the surface of the wax; and this I found to be really the case; as on scraping them with a sharp knife I succeeded in removing portions of it. On submitting these to the microscope, and appropriate tests, they showed a similar structure and chemical composition to nacre. This explanation of the prismatic colours of the casts I have since found has been also given by Vanderhoven. Still more conclusive evidence that in this case striation is not the cause of colour, consists in the fact that iridescent fragments and decalcified layers of nacre, on which no striæ can be detected, may frequently be obtained.

We must, therefore, look for something in these thin laminæ capable of producing the characteristic colours. This is to be found in their nature as thin laminæ, which decompose the light by the interference caused by the reflection from the two sides of the film or films. The power of producing colour possessed by thin films is well seen in soap bubbles, many Coleoptera and Diptera, the feathers of humming-birds, decomposing glass, and the iridescent paper prepared by De la Rue. These colours, however, must not be confused with those produced by grooved scales, as found amongst many Lepidoptera and some Coleptera.

The normal structure of one of these thin laminæ of nacre has next to be considered. It is composed of minute, much-flattened, lenticular particles, mostly presenting a hexagonal outline, the lines of separation between them being more strongly marked in one direction than in another, and having usually a highly-refracting spot in the centre; they are composed, chemically, of animal matter intimately combined with carbonate of lime. These elementary particles may somewhat modify the colours in some instances; they are large in Pinna and Haliotis, and small in Avicula; but this, however, only applies to their average size, as they vary somewhat in different parts of the same shell.

This normal condition is frequently departed from; the inner surface of the nacre presenting every transitional form between an amorphous molecular condition, a layer formed of modified rhomboidal or hexagonal crystals, flattened globules, similar to those artificially made by Mr. Rainey, and the regular structure previously described. It also frequently shows a coarse hexagonal anolation of its outer surface, owing to its firmer adhesion to the prismatic layer at the lines of junction of the prisms, causing a portion of the nacre to remain adherent to it at that spot.

From the specimens I have examined, I feel inclined to ascribe the striation sometimes seen, to much the same cause as that given by Sir D. Brewster, viz.:—the out-cropping of laminæ; but I should hardly agree with him in saying they were composed of an alternation of those of an animal, with others of a calcareous nature; for we must not lose sight of the fact, that the calcareous and animal elements are intimately combined, and modify each other by this combination; however, an excessively thin layer of animal matter may exist between those layers that are formed from these two elements.

I think it right to mention here, that a plication of the laminæ does sometimes exist, and although it does not produce the colour, yet, inasmuch as some portion of the folds will be inclined at the proper angle for the reflection of light, they will in this way contribute to the iridescent appearance of the shell, in the same manner as the corrugated mirrors, so much used now for the diffusion of light, appear brilliant at various angles. This may also be frequently seen in the transparent wings of diptera, hymenopterory, &c. Although there is generally an abrupt line of distinction between the nacreous and prismatic layers, yet, on examining the growing edge of nacre in the shell of a pinna, one frequently notices a curious transition from the prismatic structure of the external layer of the shell, into the more minute elements constituting the nacre; this modification one would indeed anticipate, if the different layers of the shell are formed in obedience to the same physical laws. Vertical sections lead to the same conclusion; viz., that the nacreous is but a modification of the previously formed prismatic layer. For the prisms of the outer layer are formed of superimposed, generally hexagonal plates, that have coalesced in a vertical direction, but still leaving evidence of their existence in the transverse striæ that mark the sides of the prisms.

In like manner the elementary lenticular particles of the nacre are arranged in vertical rows, but are more firmly united at their edges, than in the vertical direction; the result of which is, that whereas the decomposing prismatic layer separates into its elementary prisms, the nacre splits into laminæ. Examples of this may be readily obtained from fossils; but old specimens of recent pinna will frequently present a similar tendency to split into elementary parts, owing to the decay of the animal matter that exists, uncombined with lime, between the prisms or laminæ of the shell.

IMPERFECTIONS IN THE PRESENT MODE OF FITTING LIGHTNING CONDUCTORS.

BY J. N. HEARDER.

It was not long after Franklyn proved the identity of lightning and electricity, that he proposed to disarm the lightning of its terrors, by employing the means immediately suggested by the known principles of electricity.

Metals were found to afford a ready passage for electricity; and as the damage by lightning occurs, not where metals are, but where they are not, Franklyn thought that, if a conducting line of metal of sufficient size were established between the most exposed parts of a building and the ground, the lightning would choose that channel in preference to any other, and experience has shewn this to be the case. On examination of all cases of damage by lightning, it has been, and will be, found that the lightning invariably passes in the line of least resistance; so that, since metals annihilate distance, it is possible, by an examination of the relative situation of the various portions of metal about a building, to predict with mathematical accuracy the direction which the lightning will take. This being the case with an accidental arrangement of metallic bodies, it follows as a matter of course that, by an arrangement of design, we have an unlimited power to conduct a stroke of lightning through whatever channel we choose, provided the conductors are of adequate dimensions, as it is as much under control as gas or water.

If, however, the conductors are of inadequate dimensions, they are themselves destroyed by the discharge of lightning, which melts or burns them, as the case may be; and it sometimes happens that, although the conducting line may be just sufficient to prevent its own destruction, yet its route may be so circuitous that the lightning may take a short cut between

contiguous parts of the same conductor, the resistance in this direction being less than that offered by the longer line of metal.

The accidental arrangement of bell wires or gold cornices in a house may form an illustration of this; for sometimes the lightning will follow them for a very considerable distance; and, at other times, it will take a short cut across, between certain portions of the same metallic conductor, when they happen to lie near to each other, and thus form part of the line of least resistance to the ground.

When the lightning strikes a tree, it is generally observed that it passes immediately under the rind, the fluids circulating there being the best conductors; but, as they are not sufficient to mask or absorb the electricity, it passes in an embodied form, and produces all the effects of expansion which usually attend the passage of the visible flash.

It is no uncommon thing for the lightning, when it strikes a building unprovided with a conductor, to subdivide, especially where a number of very inefficient and partially conducting channels exist in various parts of the building, but having a certain degree of connection with the point first struck. The most remarkable case of this subdivision which I ever noticed, occurred a few years since, at Sherwill House, Plymouth, the residence of Caleb Trotter, Esq., who kindly permitted me to examine it minutely; the house was completely pervaded by the lightning in its descent, and almost every room showed unmistakeable traces of its action. The effects are so instructive as to deserve a minute description of them. The house fronts the south, and consists of a centre building and two wings; the former is two stories high, surmounted by a single slate roof, the span of which is sufficient to allow of a large central garret. At each end of the main building is a massive stack of chimneys. The wings on either end are only one story high, and each of these is covered with a lead flat. The front of the main building is surmounted by a parapet, within which a lead gutter runs from end to end of the main roof; a wooden shute conducts the water from the west end of this gutter to the leaden flat below, and another wood shute conducts again from this lead flat to the ground. If these had been metal instead of wood, the house would have been uninjured, as they would have formed a good conducting-line to the ground; but the want of this continuity gave rise to an immense amount of mischief. The entrance to the house is in the centre of the front, within which is a hall, having a staircase

at the back, a drawing-room on the east, and dining-room on the west side. A passage bisects the basement story longitudinally, and communicates with the wings at either end. On the north side of the passage, at the west end, is a large breakfast-room, and kitchens and other offices at the east. The arrangement of the second story is very similar to that of the basement. Bedrooms are over the drawing and dining rooms, and there is a small study over the entrance hall—the upper passage serves merely to communicate with the various rooms. The drawing, dining, and breakfast room below, and the study and two bed-rooms above, are all covered with gilded paper, and over the chimney-piece of each room—except the study—is a massive mirror, with gold frame, reaching to the ceiling. (These mirrors are, it will be understood, against the chimneys, at the extreme east and west ends in the main building.) In addition to these, a great number of pictures, with massive gold frames, cover the walls; those of the drawing-room being suspended by wire cord from a gilded iron bar passing entirely round the room under the cornice.

The lightning-cloud must have been low, and it was observed to approach the house from the S.E.—remarkably enough, the only direction in which it could have come without passing over much more elevated objects. Contrary to the generally-received opinion, the lightning did not strike the most prominent part of the building—which would have been one of the chimneys—but discharged upon the centre of the roof, about two feet above the edge of the lead gutter, rather above the level of the parapet. On the inside of the roof the plastering and laths were stripped from a surface nearly three feet square, and the edge of the lead gutter was much melted, considerable portions of the melted lead having fallen down upon the ceiling, and were picked up quite bright. The lightning, having reached the lead gutter, had now to choose the best course to the ground, and here it appears to have divided into three, if not four, channels, all of which were pretty nearly equal in their semi-conducting character. A branch of a tree at the west end reached within two or three feet of the S.W. corner, and to this branch a portion of the lightning leaped, displacing the coping of the parapet, and stripping the bark from this point in its course to the ground, the upper portion of the tree, 20 feet above, showing no signs of injury.

From the foot of this tree the discharge passed through the ground to a branch of the gas service-pipe, which supplies a light in the road immediately outside the wall. Another

portion of a discharge passed down from the same end of the gutter by the water in the wooden shute to the lead flat below. Immediately under this lead flat are the butler's pantry and wine cellar, and close to the ceiling is a bell, having two wires,—one leading into the dining-room near to the chimney on the west end, and the other to a corresponding chimney in the N.W. breakfast-room. Three ladies were in the breakfast-room, and one was sitting near the mantlepiece, when they were all alarmed by a terrific explosion and a flash of fire in the room, which occurred at one end of the mantlepiece, rendering them all deaf for a considerable time, and extinguishing one of the two gas-lights—probably from the concussion of the air, though the gas-pipe itself was partly melted, from a third branch of the lightning, in another part of the house. On examination it was found that this portion of the discharge had passed from the lead flat to the bell, thence by the bell-wire, without injuring it, into the breakfast-room; here it left the end of the bell-wire, and passed to the top of the gold frame of a massive mirror standing close to it on the mantlepiece. Here, having the choice of two conductors—viz., the gold frame or the more substantial quicksilver back of the mirror—it selects each as it suits its purpose. The portion of the upper part of the gold frame, between the bell-wire and the quicksilver back, was oxidized and destroyed, as was also a portion of the quicksilver where the lightning entered. Having passed down by the mirror, it left the lower left corner, destroying a portion of the quicksilver, and blackening and destroying the part of the gold frame over which it passed. It next took a turn out round the corner of the mantlepiece, over the gilded paper, and in again, close below, to the top of the iron grate, descending by which it got into the ground. The surface of the gilded paper was curiously oxidized in black and purple streaks. A smaller portion, in the form of a lateral discharge, passed from the same bell by the other bell-wire into the dining-room, but not in sufficient quantity to complete a discharge to the ground, as it merely melted a portion of the gold frame of the mirror over the mantlepiece, and ramified in several arborescent streaks over the gilded paper, showing exquisitely-varied tints, according to the degree of oxidation.

The third and most mischievous branch of the discharge took place through the centre of the house, near to the point where the lightning first struck the lead gutter, just over the study. About six feet to the west of this first point the lightning descended from the lead gutter two feet through

the front wall of the house, shattering the masonry, and entering the study exactly in the upper S.W. corner of the ceiling. On the west side of this room were hanging pictures with massive gold frames, and on the floor, against the same wall, stood an elegant secretary with a looking-glass back. The main portion of this discharge passed from the hole in the corner of the ceiling diagonally to the left side of a large picture-frame, passing down by that side and across the lower edge, thence to the left corner of the looking-glass at the back of the secretary, which it shattered into minute fragments, and diagonally from the right corner of the glass, taking a picture-frame in its course, down to the skirting-board on the extreme right lower corner. The gold on the frames of other pictures, as well as the gilded surface of the paper of the room, was burnt and discoloured in various places, all evidencing the ramifying character of the discharge, though the main line was unmistakeably marked by the blackness and amount of oxidation. After entering the lower corner of the room at the skirting-board, it passed out through the lath and plaster partition, setting fire to it in its course, and then over the floor on the landing outside in two distinct lines, tearing the surface of the floor for a distance of two feet, and then entering it by two holes. As the mischief could not be traced beyond this, I had the floor ripped up, and found, as I expected, a gas-pipe. This pipe was five-eighths of an inch in diameter, and of the ordinary composition of lead; it was melted on the upper part in three distinct points—not, however, sufficient to make holes, but enough to cause very deep depressions from the sinking of the lead in a semi-fluid state.

The fire within the partition was very quickly discovered by one of the female domestics, who, hearing the terrific crash in the room, which was accompanied by the fracture of every pane of glass in the window, ran up to see what was amiss. She had presence of mind enough to obtain a poker and break down part of the partition, and thus extinguish the fire. Had the gas pipe been completely melted, the escape of gas under the floor might have involved the destruction of the house. The lightning having here reached the gas pipe, it passed away by it harmlessly into the ground. Over the window of this same study was a brass curtain-pole, reaching within two feet of each end of the room. A portion of the discharge passed off to the pole just below the first point of entrance, and passing to the other end of the pole ramified in a variety of directions over the gilded paper on the side of

the room opposite to that on which the damage occurred, the principal stream being towards a gilded frame of a large picture, the lower and upper portions of which were much oxidized; but it was curious to observe that on this side of the room, as in the dining-room below, the electrical streams on the paper were characterized more by expansion and ramification, until apparently exhausted or absorbed into the surface, than by a concentration into a definite line of discharge.

A fourth part of the discharge, though much less in intensity, occurred in the east bedroom. Over the mantlepiece stood a large mirror, with gold frame reaching nearly to the ceiling. The upper and lower parts of the gilding of this frame were much injured. How the lightning got to the upper part is not quite clear, except that a small portion of the discharge in the study might have passed by a bell wire, which leads from a point near the line of the discharge to a bell which also communicated by a wire to the bedroom near the mirror in question; but it is also probable that a portion of the discharge might have passed from the lead gutter under the roof to the chimney against which the mirror was fastened, the distance being about equal in each case, and the gold paper showing discoloration on both of the upper sides of the mirror. From the lower left corner of this mirror the lightning passed along the gilded paper out round the end of the mantlepiece and down by the side as far as the hob of the grate. From the lower end of the grate it passed down to the drawing-room below, entering through the cornice and discolouring the paper as far as the metal rod which passes round the room, and which serves to suspend the pictures. The lightning passed by this rod to the north side of the room, and then down by the frame of a large picture, which was burnt and discoloured. Diagonally from the lower end of this picture it took its course over the gilded paper to the upper corner of a smaller one, partially destroying the gilding. From the lower corner of this picture it passed again down over the gilded paper, a few inches, to the hinge of the cover of a horizontal grand piano, fortunately furnished with massive metallic framework in the interior, through which it passed to the pedal wire, and through this to the floor, making its exit under the skirting to the ground. Although the portion which went in this direction destroyed all the gilded surface over which it passed, yet it did no material damage to the wall or piano, which latter was not even put out of tune. It is quite clear, by these remarkable

effects, that the tendency of lightning, when unprovided with an efficient conducting channel, is to subdivide and diffuse itself through all other available courses, selecting the best for the passage of the largest quantities, but distributing itself through other channels according to their conducting capabilities. Hence we may account for the occasional occurrence of certain amounts of damage in cases where buildings have been supplied with lightning conductors which have either become defective by time, or were originally erected without a sufficient regard to electrical requirements.

The track of the electrical discharge from the cloud to and over the surface of the earth might, if all the conditions were previously known, be a matter of mathematical calculation; but since it is impossible to predict the precise character of a cloud from which a discharge may take place, the direction of its course, or its elevation, it is extremely difficult to determine what part of a building can be considered most prominent in relation to the cloud itself, since this will vary according to the distance of position of the cloud.

By a judicious arrangement of conducting channels however, this may easily be determined, so that it should be impossible for a cloud to discharge upon any but a protected point. There is, however, another condition of things which is very rarely provided for; namely, the effectual and harmless disposal of the lightning flash after it reaches the ground. There cannot be a greater mistake than to suppose that the electrical effects cease as soon as the lightning has entered the ground, for it must be recollected that a lightning discharge is the result of the restoration of an equilibrium between two oppositely electrified surfaces; namely, the surface of the cloud and a corresponding surface of the earth, the whole stratum of atmosphere between the two being brought into a polarized condition. When a discharge takes place, the superinducing cloud, having become neutral and withdrawn its influence, the surface of the earth also regains its normal condition, in virtue of the distribution of the discharge obtained from the cloud over the formerly electrified surface; or, in case of an upward discharge to a negative cloud, by a flow of electricity from the superinduced surface of the earth to the point at which the discharge takes place.

Although the direction of the electrical currents will be different in each case, yet the instantaneous character of their action produces effects which are identical with each other, and are provided against by the same arrangements.

To illustrate this position many instances might be adduced.

The following case of Kenwyn Church, near Truro, shows the necessity of connecting all the prominent points of a building with the main conducting channel. This tower, having four turrets, had an iron lightning conductor placed by the side of one of them, and reaching originally to the ground, though in the course of years about a foot of the lower end had rusted off. In 1861 the lightning struck one of the turrets which was unprotected, nearly demolishing it in its course, and then passed from the base of the turret across the face of the tower (leaving its marks behind) to the lightning conductor, the lower end of which it melted on leaving it to enter the ground. If each turret had been properly connected with the conductor the accident would not have happened. No damage occurred after the lightning entered the conductor. If so short a distance as the few feet of interval between the two turrets is sufficient to determine the track of the electrical discharge to either, what amount of protection is likely to be afforded by a conductor placed at one or even both ends of an extended building, when they form the only conducting lines to the ground? Nevertheless, in our own town and neighbourhood, we have examples of similar scientific mistakes. Again, a conductor may reach from the top of a spire whose extreme elevation may almost command the exclusive attention of the lightning (so to speak), and extend deep into the ground, and yet not afford a sufficient protection against damage. As I have before stated, there is more to be done than merely providing a channel by which the lightning shall flow into the ground, since the channel thus provided may not be the one which the lightning will choose to assist it in its surface distribution; and it does not at all follow, because a lightning conductor is carried into the ground, or even into a well, that the lightning shall follow it to that spot if there should exist other lateral channels better suited to its work; nor will the electrical effects always cease at the termination of a conductor, if there should be an efficient conducting channel beyond the conductor, and within reach of the lightning. An example of the latter kind occurred in Plymouth many years ago. Charles' Church was furnished with a lightning conductor which by time had become very much decayed. The spire was struck by lightning, and the conductor was broken by the shock, although the church was not in the slightest degree injured. The end of this conductor penetrated some feet into the ground; but, though the lightning followed it to its extremity, yet the electrical effects did not cease here; for the

lightning passed through some 15 feet of graves, out through a wall, starting the masonry, and across a lane to a water-pipe underground, ripping up the paving as it entered. This water-pipe, ramifying all over the town, served as an admirable conducting network to facilitate the distribution of the electricity over the surface of the ground, and thereby to restore equilibrium.

In Manchester, a few months since, a church was struck by lightning during divine service. The lightning-conductor saved the spire and tower from damage so far as it constituted the correct channel for the discharge, but there happened to be a short cut to a network of conductors in the form of gas-pipes—not in extension of the line of the conductor, but a few feet from the ground; the lightning, therefore, did not pass to the extreme end of the conductor, but left it at the point nearest to these gas-pipes, and bursting through the end wall of the church, and damaging the masonry, it passed across the churchwarden's seat to the gas-pipe, where, meeting with all its requirements, no further mischief occurred beyond the crippling and bending of the small pipe at the place where the lightning laid hold of it. It is more than likely that any individual who might have happened to be in the part of the seat through which the lightning passed would have been killed; or had the course of this portion of the discharge been through inflammable materials, fire and damage might have been the result, and the opponents of lightning-conductors—if any can now be found—might have been furnished with an argument against their use.

Lightning is very nice in the choice of its conducting channels, selecting the best, even where there is a shade of difference. For instance, it will generally prefer the outside to the inside of a chimney—the tarry deposit in the interior offering more resistance, unless very thickly covered with soot, than the plastering on the exterior, especially if old or damp. Another remarkable exemplification of this election occurs in the occasional destruction of animals which may have taken shelter under a tree during a thunder-storm. The lightning strikes the tree, and, if no other conductors be present, passes down to the ground, and distributes itself over it in the best way it can. If a man or any other animal be close to the tree, the lightning will choose the living body in virtue of its superior conducting quality, and leave the tree the moment it reaches it; and should a flock of sheep have congregated under the tree, the lightning will avail itself

of their bodies to distribute itself over the ground, they being better conductors than the ground itself.

The amount of inductive action taking place between the clouds and the earth is something enormous, giving rise to currents in the ground from one part to another during the changes of electrical condition in the clouds, even arising from discharges from one cloud to another. The strata of the atmosphere in the immediate vicinity of the clouds and the earth partake of the electrical conditions of the surfaces to which they are respectively approximated, and also participate in the electrical changes incident to them. For example, an insulated wire of 400 feet in length, extended about 20 or 30 feet above the earth's surface, which I employed as a test for this purpose, has occasionally, during the occurrence of a flash of lightning in the clouds, even at a mile distance from it, thrown off to a receiving conductor connected with the ground a bundle of sparks at once, resembling a flame of fire, and accompanied by a loud cracking noise. When this wire communicated with an electrical battery, containing 16 feet of coated surface, the inductive action of a single flash would furnish electricity enough to cause it to discharge over an interval of more than a quarter of an inch twenty or thirty times in a second. If so prodigious a quantity of electricity can be taken up from the portion of the atmosphere immediately surrounding a small wire of this kind, what enormous quantities must be taken up and distributed by the various surfaces with which, perhaps, hundreds of acres of electrified atmosphere are in contact! The blighting effect of lightning may in this way be accounted for without much difficulty. These inductive accompaniments to electrical discharges occur under whatever circumstances they are produced. It is impossible to draw an electrical spark from the conductor of an electrical machine in a room without causing an electrical disturbance not only in every surface of the room in which the spark occurs, but in every other room in the building, and the amount of this disturbance will depend on the power of the spark.

By means of an instrument which I invented many years since, to which I gave the name of Statiscope, these disturbances are easily rendered evident, and they serve to show that in all cases of lightning discharges, whether between the clouds themselves or between the clouds and the earth or sea, electrical currents take place in consequence of the endeavour of the surface to regain its normal condition. Persons occasionally have, on board ship as well as in houses, declared

that they have felt electrical shocks at the moment of a flash of lightning, though there has been no evidence of either ship or house being struck; but I believe that it is possible for an individual to be so placed as to form part of the circuit in which these surface currents pass, and thus become affected by them. I have myself purposely arranged wire so as to explode gases by these currents, though the wires themselves could not possibly conduct any of the electrical discharge which produced the effect. From a careful consideration of these phenomena it will be seen that there are certain conditions to be fulfilled in any arrangement having for its object the effectual preservation of a building from the effects of lightning; and if these be applied as a test in the examination of the present practice of erecting lightning-conductors, it will be found that, as a rule, the system is extremely defective—a very large majority affording a very equivocal and limited amount of protection, whilst it is a matter of doubt if even the very best provide in all cases for the safe distribution of the lightning-flash after it has reached the earth.

ON THE DEAF AND DUMB.

BY DR. SCOTT.

At the last meeting of the Association, I had the honour of bringing before you the subject of Deaf-mutism. On that occasion I confined my observations to some examination of its prevalency, in what proportion it occurs in different countries, and to what causes it is chiefly to be attributed.

In my present paper I purpose to show its effects upon those who suffer from it, and to give some account of the modes which have been invented for the amelioration of the condition of the Deaf-mute.

Previously, however, to entering upon the subject of to-day, I may be allowed perhaps to give a short *résumé* of what was stated at our last meeting.

It was then stated that statistical enquiry had shown the prevalency of this disease to be about *one* in 16,000 of the population generally; that it prevailed more in some districts than in others, our own western counties being one of these districts in excess, it having the proportion of one in about 14,000, while in the London district the proportion fell to about one in every 17,000 persons; thus showing that it was chiefly amongst rural populations where it prevailed most, while in the more densely populated parts its effects were less visible.

It was then also stated, that the causes to which the disease had been attributed were, first and generally, a constitution enfeebled by a strumous taint; while the more proximate causes were—fright experienced by the mother during gestation; too close consanguinity, or the inter-marriages of near relatives; and family peculiarity and hereditary taint. From our best sources of evidence, then, we find in this country a population of 12,553 deaf and dumb persons. In concluding my last paper, I put the question, Is deaf-dumbness curable?

and to this serious question I replied, that experience answers, it is not. There is no evidence that I can find of a true cause of congenital deafness having been cured, and all persons who have become deaf at an early age must be ranked in this category.

Since science then, which has done so much, has hitherto failed to restore hearing to this afflicted class of persons, it is my purpose to-day to enquire how far morally and intellectually their case can be ameliorated.

Let us suppose ourselves passing along the streets of Plymouth. We see around us children playing, and shouting, and indulging in the usual exuberances of physical nature incident to the time of youth. Amongst this busy troop—but not quite of them, for he dwells apart—is one not mingling in these romps. He stands looking on, but speaks not. We look again. He is not different in any outward appearance that we can see to those who are playing around him; why does he not join with them? he must be offended with some of his comrades; let us step up and ask why his voice mingles not with the voices of his playmates. We do so; but he only answers us with a stare of vacant wonderment! He cannot speak—he is deaf and dumb! Here, then, we see the deaf and dumb child is shut out from communication with his fellows. He cannot hear their speech, he cannot learn it, and hence he remains isolated even in the midst of society. He has learned none of that mother-lore taught at the apron string; received none of her careful warnings from vice; nor has he ever had his thoughts directed to anything beyond what he sees, and even of these he has no explanation. To him the world has been for ever voiceless, only remaining one huge pantomime, and to the understanding of which he has no key.

An eminent philosopher, Dr. Thomas Brown, remarks: "To be without language, spoken or written, is almost to be without thought. We must not think in a speculative comparison of this sort of mere savage life: for the rudest savages would be as much superior to a race of beings without speech, as the most civilized nations at this moment are compared with the half-brutal wanderers of forests and deserts."

In our social intercourse, language constitutes the chief delight, giving happiness to hours, the wearying heaviness of which must otherwise have rendered existence an insupportable burden. In its more important character, as fixed in the imperishable records which are transmitted in unin-

terrupted progression from that generation which passes away to the generation which succeeds, it gives to the individual man the product of all the creative energies of mankind, extending to even the humblest intellect, which can still mix itself with the illustrious dead, that privilege which has been poetically allotted to the immortality of genius of being "the citizen of every country, and the contemporary of every age." From this eloquent description of the advantages which the faculty of speech bestows on man, we are able, in some degree, to estimate how sad must be the lot of those who are afflicted with its deprivation, or those who are born deaf and dumb.

The deaf-mute, placed in a position where the usual means of communication are denied him, is obliged to fall back on some other, or remain entirely shut out from all intercourse with his fellows. Nor can he obtain instruction by the methods usually employed. Hence, some plan must be devised fitted for his peculiar condition, if he is to be instructed at all.

Now, situated in the isolation we have described, the deaf-mute does make an effort to get into communication with others, and to some extent he succeeds. He falls back upon a language which may be termed universal, but which has been almost entirely lost amongst civilized peoples, though still used amongst savage tribes to a considerable extent. This language is the language of signs, or pantomime.

By this language of signs we are first enabled to reach the mind of the deaf-mute, and to place him in a condition to communicate with his fellow-creatures; and so, step by step, we are able to make him comprehend his duties here as a citizen, and as a Christian, and to elevate his mind to the contemplation of that better land of which, but for this special instruction, he could never have had the faintest glimpse.

Having thus shown the mental darkness to which deafness from birth reduces those who are its victims, I shall next refer to those means which, by the persevering energy of benevolent men, have been invented for its amelioration. But before giving any detailed account of these, it may be advisable to take a hurried glance at the history of the art.

No doubt deaf-mutes have existed from the earliest periods; but the notices which have come down to us regarding them are meagre and few. Probably they were classed amongst those diseased in mind, and were generally either entirely neglected, hid away from the eye of society, or looked

upon with the vulgar as being "uncanny," as the Scotch say, and were consequently feared and avoided. One of the earliest records of their instruction is found in the ecclesiastical history of the Venerable Bede; and though it is there noticed as a miracle performed on the young man spoken of, there is no doubt it was an early attempt, and, from the tenor of the results, may be considered as a not very unsuccessful one, to teach the deaf-mute to articulate from the motion of the lips.

The person who performs the miracle is Bishop John of Hagulstad (now Hexham), in Northumberland. This bishop had a solitary mansion, where he used at times to seclude himself for solitary purposes, especially at the season of Lent. On one such occasion, desiring at the same time an object on which to exercise his charity, he caused to be brought to him a young man whose case and cure are thus described:—"There was, in a towne not far off, a younge man that was dumme, and well known to the Bishop (for he used to come before him oftentimes to receive his almes), who was never able to speake so much as one worde. This impotant Lazar the Bishop commanded to be brought thither, and a harbour to be made for him within the precinct of his house, where he might ordinarily every day receive his almes. And when one week of Lent was past, the next Sunday he willed the poore man to come unto him. When he was come, he bydd him put out his tongue and shew it unto him; and taking him by the chinne made the sign of the Holy Cross upon his tongue; and when he had so signed and blessed it, he commanded him to plucke it in again and speake, saying, 'Speake me one word; say, Yea, yea.' . Incontinent the stringes of his tongue were loosed, and he said that which he was commanded to say. The Bishop added certain letters by name, and bid him say A. He said A. Say B, and he said B, &c., and when he had said and recited after the Bishop, he put unto him sillibles and whole wordes to be pronounced. Unto which, when he answered in all points orderly, he commanded him to speake long sentences, and he did so."

Now here is a cure, and apparently a pretty successful one of a deaf man being taught to articulate so early as the eighth century, as Bede died in 735. It appears, however, to have been an isolated case; and as it appeared rather as a miracle than a result of human effort, probably no one who knew of the case ever attempted to obtain similar results.

After seven or eight hundred years had rolled away, we meet again with an effort to educate the mute. A person

named Rudolph Agricola (who died in 1485) mentions the case of a deaf and dumb youth whom he had taught to read. In the 16th century, a learned monk—Pedro Ponce—taught, with success, some deaf and dumb persons. He left no records of his plans, but the fact of his success is recorded by two of his contemporaries. Father Ponce died 1584. In 1620, John Paul Bonet—a Spaniard—published the first work on the subject; and we learn from its contents that he considered himself the inventor of the art. Soon after this period we find various persons engaged with experiments on the deaf and dumb, and generally they have left records of their proceedings.

But the real work of educating the deaf and dumb began about the middle of the last century, and the two names associated with the movement are those of De l'Epée, in France, and Hernicke, in Germany. To these two benevolent men the modern results of deaf-mute instruction are chiefly owing. It is somewhat remarkable, that they differed in their methods, and had some sharp words in the defence of their respective systems. Hernicke was the great advocate for instruction by means of articulation, and De l'Epée maintained that signs or gestures was the best and shortest means of accomplishing the object. Which had the best of the argument, where both were more or less wrong, it is not worth while here to examine; but it is unfortunate to mention, that partisans of each side still exist, which, in some instances, carry their views so far as to injure the usefulness of the art itself. Since the time of these fathers of institutions for the education of the deaf and dumb, there have sprung up over all Europe and America establishments for this object, and this class of sufferers, so long left in darkness and neglect, can now be restored to all the blessings of social, moral, and Christian light.

Having now sketched thus hastily the history of the art, I shall go a little more into detail as to the means used in this kind of instruction. These means are:

Firstly—Signs, or gestural language, with which may be classed pictures, models, and illustrations of various kinds.

Secondly—Articulation, which may be divided into speaking and lip reading.

Thirdly—Dactylology, or spelling on the fingers.

Fourthly—Writing and reading.

Different teachers have estimated these aids at different degrees of importance, but all are more or less employed. There may be said to be at present three distinct systems or

modes of teaching deaf mutes, viz., the French, the German, and the English.

The French system has chiefly made use of signs, which it has developed to a wide extent into what has been termed methodical signs, but it has paid little or no attention to articulation.

The German system, on the contrary, uses speech as the principal means of instruction, and endeavours to make all its pupils articulate. It forbids the use of signs as far as possible, and uses as little as may be the manual alphabet.

The English system adopts an intermediate course between the French and the German. Like the former, it employs signs as the great means of imparting instruction, but confines itself chiefly to natural signs, and employs but sparingly those methodical additions adopted by the French. It uses, like the Germans, articulation, though in most of the British schools this has been abandoned as impracticable, when extended over a number of pupils. But it is still taught to such pupils as indicate an aptitude for its acquirement.

The American schools professedly follow the system of the French, though, as far as methodical signs are considered, they have of late years appeared more to adopt the method of the English, and they have never introduced articulation. I cannot help here paying a tribute of admiration to the Americans for the zeal they have manifested in the cause of the deaf and dumb. Two institutions of that country have each sent their masters over the chief countries of Europe to see what was doing in deaf-mute instruction, and their reports are the most valuable contributions we have in the literature of deaf-mute instruction.

First, then, as to this language of *gesture*, which I have stated as our first means of getting at the mind of the deaf-mute.

Suppose any of us were cast upon an island, the language of its inhabitants being unknown to us, while they were equally ignorant of ours; what should we do, if we wanted food? What we should do would be to make the sign of eating, as we call it; we would put our hand to our mouth, and make our jaws move as we do in the act of masticating food, and then, by a look of enquiry and supplication, endeavour to make the persons around us know our wants. Now this kind of communication is what we term the language of signs.

In teaching the deaf-mute, we are endeavouring to give him the language of his country, and this rude, natural sign

language not having the copiousness and verbal modification found in a cultivated language, we endeavour to engraft on it another kind of signs, which is more in accordance with our grammatical changes, and these artificial developments are termed *methodical signs*. There is still another class of signs, which is termed *arbitrary*, and may be instanced by holding up the *thumb* as a sign for *good*, or general approval, and by holding up the little finger as a sign for *bad*, or disapproval. As you will easily see, the latter two classes of signs are by no means of the same importance in our teaching as the class termed *natural signs*. This last class of signs is that which the deaf child itself has fallen back upon to express its wants to those around it, before it comes under instruction at all; so it is this language, common to all mankind, though almost lost sight of amongst civilized peoples, on which we are chiefly dependent for our recovery of the deaf and dumb from their state of ignorance and isolation.

Let us see how we would first commence teaching a word by this means. Suppose the word *hat* was to be taught. We would first show the pupil the real object, or its picture, and if he had seen a hat he would at once recognize it, and he would make the sign of putting something upon his head. When he had done this, we would write down the word *hat*, and show him that this arbitrary combination of forms expressed the same idea as the sign he made. To impress this more strongly upon his mind, we would take away the hat itself, and rub out the picture on the wall, and leave nothing but the written word. Then we would call an older pupil, and point out the word hat only, when he would at once make the sign of putting it on the head. Thus the noviciate would see that there was a connection between the word and the idea, without the real hat or the picture appearing at all in the process. This kind of thing would be repeated with several common objects with which the pupil was familiar, and his vocabulary extended in such simple names, till he was thought capable of being introduced to the next class of easiest words, such as the most observable qualities, or *adjectives*. These would be taught in a similar manner to what we have shown was the case with nouns; and, after we had made some little progress here, we would introduce *verbs* as employed in the commonest actions, such as *eating*, *writing*, *bringing*, &c. After this, we are able to get a little sentence formed; and so we progress, advancing gradually from the simpler to the more difficult, till we get such an acquaintance

with language, as to be able to carry on communications by the means of question and answer.

From this it will be readily perceived that our progress in deaf-mute instruction must necessarily be slow, and for the deaf and dumb to acquire even a fair use of the English language is an accomplishment of no easy acquirement, but requires much laborious effort, both on the part of the pupil and teacher.

I have said *articulation* is one of the means used, especially in Germany, in deaf-mute instruction. Now, articulation is taught by teaching the pupil to imitate the motions and the position of the lips, and other vocal organs of the teacher as used in speaking; and this, in some instances, is successful, while in other cases it is not so. But in the most successful cases of articulation, there is a monotony of voice and a want of accentuation and emphasis that never can be got over, which gives to the speaking of deaf an unpleasant and unnatural character.

There are two classes of persons who are sometimes pushed forward as examples in articulation who, of course, ought not to be considered so; viz., those who have learned to speak before becoming dumb, and those who have a considerable degree of hearing remaining. It cannot be doubted for a moment that with both these classes to teach articulation is important, but the success obtained in such cases must not be taken as a guide for cases of real mutism, or as an example of what can be done in articulation with the deaf and dumb generally, for it would be deeply fallacious in both instances. Experience, then, would teach, that while on some occasions it is advisable to teach articulation, it is better in the mass of cases not to do so; while to give up the use of signs or neglect instruction in written language would be a serious error. Nor can articulation, nor indeed anything else, ever take the place of natural signs, and for this very good reason, that nothing else ever can. I have more particularly alluded to this point, because some friends of the German system in this country, mistaking the true scope of that system, have argued as if signs were an evil; whereas even one of the best of the German teachers (Jaeger) says, "Nothing can be imagined more tedious, wearisome, and inexpressive than oral communication with a deaf-mute would be, even after his education is completed, if it were not enlivened by corresponding signs." Again, the Germans have been greatly misrepresented by paragraphs which have got into the newspapers, as to the wonders they perform in articulation, and

which indeed make them appear, in the eyes of those who can really judge on such questions, as nothing better than quacks. We are told, for instance, "that the deaf and dumb are enabled, by the sense of feeling, to distinguish in the dark what is said!" which, says an accomplished German teacher, is "an absurd fable." Again, it has been said, "that the deaf and dumb, after learning to read, take great delight in poetry; the measure of the verse waking up a dormant faculty within them, giving them the pleasure of what we call time, although they have no ear to perceive it." What say the Germans themselves to this? First, they say that the deaf-mute is seldom sufficiently master of language to well comprehend poetry; secondly, that he cannot read with sufficient fluency to make out the rhythm; and, thirdly, provided that he could do so, it would afford him no more pleasure than would the swinging of the pendulum of a clock." I have thought it necessary to allude to these observations, because they appear to have a greater number of believers than would be at first imagined, and because they tend to beget altogether extravagant notions of the capabilities of the deaf and dumb in attaining the use of articulation.

Dactylology, or reading on the fingers, is the next auxiliary to be noticed.

The Finger Alphabet is generally thought to be a valuable auxiliary in our instruction; but the truth is, it has *no specific value*, and is only a short and convenient method of communication *after* the pupil has learned language, and is nothing more than, as De Gerardo has designated it,—"writing set free from its material dress." There are two finger alphabets: one where two hands are used, and one where only one hand is used. The former is chiefly used in this country, while the latter is the one most—indeed, altogether—employed on the continent. The finger alphabet is sufficiently well known to need no description; and as it is only employed as another kind of writing in teaching, it will be unnecessary to say more upon it here.

You will remember the manner in which I said the names of various objects were first introduced to the pupil in writing. At this time, also, we commence to teach the pupil to spell on the fingers. As well as shewing him the h-a-t written on the wall, we also shew him the h-a-t made on the fingers, and thus he gets the two modes, viz., ordinary writing or spelling, and spelling on the fingers together; and so you will perceive that Dactylology is only another manner of spelling the words which he knows.

The last auxiliaries we have to consider are writing and reading, and which are useful in the same way that they are useful to ordinary persons; for when we get our pupils to use these pretty freely, a good deal of the peculiarity of their teaching ceases. We have already shown how they begin to learn words and to write them, and, by a continuation of a similar process, of exemplifying the use of words by gestures illustrative of the actions or things of which they are expressive, and by making the language already learned teach that which is yet to learn, we by degrees build up the intellectual masonry, course upon course, till we get an edifice more or less perfect, according to the materials we have to work on.

When an ordinary child goes to school he commences learning to read. He has already, before entering a school-room, learned to speak and converse in his mother tongue, and can express himself freely on any subject with which he is acquainted, so that when he begins his school instruction, he has only to learn to associate certain written or printed forms with certain sounds which are already known to him, and which he can use as language; so that when he has learned these forms, he can read anything in ordinary language.

It is very different with the deaf and dumb: they have learnt no language; they know no words whatever, either written or spoken; so that they have not only to learn to associate the written or printed word with the idea, but to learn that the idea is associated with any arbitrary characters at all. Language, therefore, becomes their great difficulty, and requires the most laborious efforts, both on the part of the teacher and pupil, to overcome. Nine-tenths of the time the deaf-mute spends at school is devoted to the acquirement of language; and then, when he leaves, he has got only a very imperfect use of it, but generally enough to enable him to get into conversation with those by whom he is surrounded, by which means he daily improves his incorrect expressions, and perfects in his intercourse with society that which he has begun in the school-room. So difficult is this acquirement, that in no known instance has a deaf-mute ever, by his own self-help, overcome the obstacles in his path, and placed *himself* in a position to communicate with his fellows by this means. I need say nothing stronger to show the claims he has upon our assistance to help him. Of course, as the pupils advance in a knowledge of language, they are enabled to obtain information of various kinds, like other children; but, prac-

tically, we do not wait till they can read to give them instruction in the various branches of knowledge: we commence to do this at once they are introduced to us, by the means of signs, and find no difficulty in so doing. Indeed, signs always remain our great means for explaining difficulties in all stages of their instruction, and, as I have already said, nothing else can ever take their place; they are the vernacular of the deaf-mute, and he clings to them through life as the language nearest and dearest to him.

I have now indicated—for in a paper of this kind one can only indicate—the chief features connected with the system of deaf-mute instruction, and in doing so I trust I have said enough to make it generally understood. To have entered more into details might have been tedious, and occupied time which was required for other subjects.

In conclusion, allow me to say one word in behalf of this suffering class, and to express the hope that, in endeavouring to make their case better known, I have excited an extended sympathy for their sufferings. There are, doubtless, many cases of misfortune that call for the aid of the benevolent, but there are few who present stronger claims than those whose case we have been considering. Persons so afflicted, if left without help, remain even in the midst of society little better than savages of a heathen country. They know no God, no Saviour, no duties, no law but the instincts of their own passions, and see no light beyond the dark portals of the grave. But, under the fostering care of instruction, they can be brought to be intelligent members of the great human family, and enabled to raise their eloquent eyes to heaven, and say, "I, too, am a man and a brother."

W. Brendon, Printer, Plymouth.

REPORT AND TRANSACTIONS

OF THE

DEVONSHIRE ASSOCIATION

FOR

THE ADVANCEMENT OF SCIENCE, LITERATURE, AND ART.

[TORQUAY, JULY, 1864.]

PART III.

LONDON:
TAYLOR & FRANCIS, RED LION COURT, FLEET STREET.
PLYMOUTH: W. BRENDON, GEORGE STREET.
1864.

CONTENTS.

OFFICERS.

1864–65.

President:

E. VIVIAN, Esq., M.A., &c.

Vice-Presidents:

W. PENGELLY, Esq., F.R.S., F.G.S., &c.
A. B. SHEPPARD, Esq., *President of the Board of Health, Torquay.*
C. SPENCE BATE, Esq., F.R.S., F.L.S., &c.
REV. R. H. BARNES, M.A.

Hon. Treasurer:

W. VICARY, Esq., F.G.S.

Hon. Local Treasurer:

G. HEARDER, Esq.

Hon. Secretaries:

REV. W. HARPLEY, M.A., F.C.P.S.
H. S. ELLIS, Esq., F.R.A.S.

Hon. Local Secretary:

E. APPLETON, Esq., F.I.B.A.

Council:

E. APPLETON.
T. F. BARHAM.
C. SPENCE BATE.
SIR J. BOWRING.
J. DIVETT.
W. S. M. D'URBAN.
H. S. ELLIS.
W. GAMLEN.
A. H. A. HAMILTON.
W. HARPLEY.
R. H. BARNES.
G. HEARDER.
J. N. HEARDER.
G. W. ORMEROD.
W. PENGELLY.
G. PYCROFT.
C. RIDGWAY.
J. E. RISK.
A. B. SHEPPARD.
W. R. SCOTT.
W. VICARY.
E. VIVIAN.

LIST OF MEMBERS.

Abraham, B. T., *Heavitree, near Exeter*
Appleton, Edward, F.I.B.A., *Cotswold, Torquay*
Balkwill, Fred., *Plymouth*
Barham, T. F., M.D., *Highweek, Newton Abbot*
Barnes, Rev. R. H., M.A., *Mary-church, Torquay*
Bastard, S. S., *Summerland Place, Exeter*
Bate, C. Spence, F.R.S., F.L.S., &c., *Plymouth*
Berry, Richard, *Chagford*
Bowring, Sir John, LL.D., F.R.S., &c., *Claremount House, Exeter*
Brent, R., M.D., *Woodbury*
Cann, Wm., *West of England Insurance Office, Exeter*
Cawdle, W., *Torquay*
Cole, Robt., F.S.A., 54, *Clarendon Road, Notting Hill, London*
Colley, J., *Plymouth*
Cresswell, C. H., *Heavitree*
Dabb, Jas., *Plymouth*
Dansey, Geo., M.D., *Stoke, Plymouth*
Derry, W., *Houndiscombe House, Plymouth*
Divett, John, *President of the Teign Naturalists' Field Club, Bovey Tracey*
Donne, W., *Torquay*
D'Urban, Major-Gen., *Newport, Exeter*
D'Urban, W. S. M., *Newport, Exeter*
Elliot, W. H., M.D., *Bouverie House, St. Leonard, Exeter*
Ellis, Henry S., F.R.A.S., 1, *Fair Park, Exeter*
Evanson, —., M.D., *Torquay*
Finch, T., M.R.C.S., *St. Mary Church*
Follet, John, *Mount Weir, Exeter*
Fook, J. V., *Plymouth*
Fox, S. B., *Southernhay, Exeter*
Gamlen, W. H., *Tiverton*
Gendall, John, *The Close, Exeter*
Glanville, S., *Bouverie Place, St. Leonard, Exeter*
Gwatkin, Rev. R., B.D., F.G.S., *Torquay*
Hamilton, A. H. A., *Millbrooke, near Exeter*
Harland, C. J., *Torquay*
Harpley, Rev. W., M.A., F.C.P.S., *Plymouth*
Harris, Sir W. Snow, F.R.S., &c., *Plymouth*
Hayward, John, *The Close, Exeter*
Hearder, G. E., *Torquay*
Hearder, J. N., *Plymouth*
Hedgeland, R. W., M.A., *St. Leonard, Exeter*
Hext, Rev. J., *Kingsteignton*
Hine, J. E., C.E., *Plymouth*
Horne, F. B., M.R.C.S., *Torquay*
Jeffery, E., *Dix's Field, Exeter*
Jones, Winslow, *St. Loyes, Heavitree*
Kendall, W., J.P., *Summerland Place, Exeter*
Littleton, T., M.D., *Saltash*
Mardon, Rev. B., M.A., *Sidmouth*
Miles, W., *Dix's Field, Exeter*
Moore, W. F., *The Friary, Plymouth*
Nankivel, C. B., M.D., *Torquay*
Ormerod, G. W., M.A., F.G.S., *Chagford*
Owen, Col., C.B., R.E., *Leigham Terrace, Plymouth*
Palk, Sir Lawrence, M.P., *Haldon House*
Parfitt, Edward, *Devon and Exeter Institution, Exeter*
Peacock, Geo., *Starcross*
Pengelly, W., F.R.S., F.G.S., &c., *Torquay*
Phillips, J., *Torquay*
Pollard, W., Jun., M.R.C.S., *Torquay*
Pycroft, A., *Kenton*
Ridgway, C., PH.D., *Marlborough House, Exeter*
Risk, Rev. J. E., M.A., *Plymouth*
Reading, J. J., M.E.S., *Plymouth*
Richardson, J., *Plymouth*
Rogers, W., *Countess Weir, near Exeter*
Rooker, A., *Plymouth*
Roper, C. H., M.R.C.S., *Magdalen Street, Exeter*
Rowe, J. Brooking, F.L.S., *Plymouth*
Scott, W. R., PH.D., *St. Leonard, Exeter*
Sercombe, Rupert, *Fairfield, Exeter*
Shapter, T., M.D., *Barnfield, Exeter*
Shute, R., *Baring Crescent, Exeter*
Spragge, T., *Torquay*
Spragge, W. H., *Torquay*
Stewart, R., M.R.C.S., *Torquay*
Stewart, C., M.R.C.S., *Plymouth*
Teesdale, C. L., *Swiss Cottage, Exeter*
Templeton, J., M.A., F.G.S., *Exeter*
Tetley, —, M.D., *Torquay*
Thomas, J. L., *Exeter*
Tracey, Rev. Eugene F., M.A., *Ford Park, Plymouth*
Turner, T., *Manston Terrace, Heavitree*
Vicary, W., F.G.S., 7, *Albert Terrace, St. Leonard, Exeter*
Vivian, E., M.A., &c., *Torquay*
Vivian, R. H. D., *Torquay*
Walker, F., 4, *Queen Street Road, Exeter*
Weeks, C., *Torquay*
White, G. T., *Torquay*
Widger, W., *Torquay*

Life Members.

Lyte, F. Maxwell
Sheppard, A. B., *Torquay*

BYE-LAWS.

THE objects of the Association are—to give a stronger impulse, and a more systematic direction, to scientific enquiry, and to promote the intercourse of those who cultivate science, literature, and art, in different parts of Devonshire, with one another, and with others.

ADMISSION OF MEMBERS AND ASSOCIATES.

All persons present at the first meeting shall be entitled to become members of the Association upon subscribing an obligation to conform to its rules.

All other persons desirous of becoming members shall be nominated by a member.

All members shall pay the sum of 10*s.* annually, and have the privilege of a Lady's Ticket.

Elected members may become members for life on a single payment of £5.

Associates for the meetings shall pay the sum of 5*s.*, and Ladies 2*s.* 6*d.*

The Association shall have the power of electing Honorary Members, chosen from such eminent men as may be connected with the West of England, and Corresponding Members, from persons at a distance, who may feel an interest in this Association.

REPORTS.

The Association shall, within six months after each annual meeting, publish a Report, including the Laws, a Financial Statement, and a List of the Members.

All members who have paid their subscriptions shall be entitled to receive a copy.

MEETINGS.

The Association shall meet annually, at such time and place as shall be decided on at the previous annual meeting.

GENERAL COMMITTEE.

The General Committee shall sit during the time of the meeting, or longer, to transact the business of the Association.

It shall consist of Presidents and Officers of the present and preceding years, together with all members of the current years.

The General Committee shall have the power of authorising such sums of money as may be convenient, from the funds of the Association, for the purpose of scientific investigation.

LOCAL COMMITTEES.

Each annual meeting shall appoint a Local Treasurer and Secretary, who, with power to add to their number, shall be a Local Committee to assist in making such local arrangements as may be necessary.

OFFICERS.

A President, two or more Vice-Presidents, one or more General Secretaries, and a General Treasurer, shall be appointed at each annual meeting.

The President shall not be eligible for immediate reelection.

COUNCIL.

In the intervals between the annual meetings, the affairs of the Association shall be managed by a Council appointed at each annual meeting; the General and Local Officers, and Officers elect, being *ex-officio* members.

ACCOUNTS.

The Accounts of the Association shall be audited annually, by Auditors appointed at each annual meeting.

THE REPORT OF THE COUNCIL,

As presented to the General Committee, at Torquay, July 20th, 1864.

THE Council of the Devonshire Association for the Advancement of Science, Literature, and Art, in this their Second Annual Report, have the pleasure to announce the continued success of the Association. The list of Members has been considerably enlarged, and the number of papers read and discussed at the General Meeting at Plymouth, in July, was greater than in the previous year.

The affairs of the Association were conducted under the auspices of the gentlemen who were selected to fill the various offices, and whose names have already appeared in the last Report of the Council.

It having been resolved that the second meeting should be held at Plymouth, the 29th of July was appointed as the day for the commencement of the sittings. On this day the Members assembled at the Athenæum, and the President, C. SPENCE BATE, Esq., delivered his Address.

On the 30th, the Association met at 11 o'clock, when the following papers were read and discussed:—

On the Chronological Value of the Red Sandstones and Conglomerates of Devonshire	*W. Pengelly, Esq.*, F.R.S., &c.
On the Devonshire Caverns...	*E. Vivian, Esq.*, M.A.
Some Remarks on Recent Controversies respecting the Antiquity of the Human Race	*Rev. J. E. Risk*, M.A.
On Self-registering Hygrometers, and the Climate of South Devon...	*E. Vivian, Esq.*, M.A., M.B.M.S.
Some Remarks on Recent Additions to the Fauna of Devon	*J. Brooking Rowe, Esq*, F.L.S.
Our Homes	*E. Appleton, Esq.*, F.I.B.A.
On Morphology in Primula Acauilis Flori-Pleno Carneo	*E. Parfitt, Esq.*
On the Deaf and Dumb...	*Dr. Scott.*
On the Structure and Cause of Colour in the Nacreous Layer of Shells ...	*C. Stewart, Esq.*, M.R.C.S.
Imperfections in the Mode of Fitting Lightning Conductors	*J. N. Hearder, Esq.*

ADDRESS.

BY

E. VIVIAN, M.A.

SCIENCE, Literature, and Art, the advancement of which is the object of the Devonshire Association, include the entire range of human knowledge. Science takes cognizance of abstract truth—the works and laws of the Creator; art is its practical application to purposes either of utility or ornament; literature is the record of both. The sources of knowledge are Divine revelation, human intellect, and the phenomena of nature; hence the various methods,—the objective and the subjective, the metaphysical and the scientific. In the harmony of these, alone, is truth to be discovered, in its integrity and full practical efficiency.

In his very able Introductory Address, my predecessor directed the attention of this Association to the earnest research which characterizes the present age in all these branches of inquiry. "The promulgation of an error," he says, "has never yet done harm to mankind, if its discussion be not prevented. The great enemy to truth is apathy; .... no greater curse can rest upon a people, than a passive acquiescence in unexamined traditions." In the same spirit, I would again invite communications from our members; but, in conducting the discussions which may arise upon them, I believe it is your wish that I should add the usual caution, that they must not degenerate into party politics, or controversial theology.

Before adverting specially to the progress which has been made during the past year, I propose to take a more general review of the present state of human knowledge, and especially of the several methods of inquiry, with their effect upon the welfare of mankind, as compared with those which existed in the most enlightened period of classical antiquity.

If Aristotle's four hundred treatises had come down to us

entire, they would have afforded an encyclopædia which might readily have been compared with those of the present day; the portion which is still extant will suffice, with information afforded by other authors.

At the period which I have selected for this comparison, the intellect of Greece had attained its highest development; its political and social condition afforded the greatest freedom to thought; and, in addition to the learning of Egypt and the East, the expeditions of Alexander had given to his great preceptor the means of far extending his researches in geography, and every branch of natural history and science. In theology and ethics, the light of revelation had not yet extended into Greece; but the philosophical mind had, in great measure, thrown off the trammels of superstition, and had formed its creed solely by the light of nature, and, perhaps, some dim patriarchal traditions.

The first grand division, recognized in modern science, is into Matter and Force. As far as analysis yet extends, sixty-four elements compose the material universe, including, if reliance can be placed upon the spectrum, the entire stellar as well as solar systems. The Atomic theory assigns to these some definite form, or possibly polar force, which characterizes their ultimate particles; these coalesce into groups of molecules, chemically united, and capable of forming higher combinations, but always in definite proportions. The Imponderables, as heat, light, electricity, and magnetism, with chemical action, mechanical power, and, possibly, attraction and gravitation, are now regarded as forms of motion or force, the sum of which, in common with that of matter, is incapable either of increase or diminution, but which, unlike matter, admits of correlation or interchange with other forms of force.

In ancient physics, matter was considered to be eternal, *De nihilo nihilum in nihilum nil posse reverti*, and in the days of alchemy, capable of transmutation; but there seems to have been no conception of the conservation or correlation of force. According to Plato, the four elements were—earth, air, fire, and water, the ultimate atoms of which possessed some specific character, the particles of earth being cubical; those of fire being pyramidal; air, in the form of an octahedron; and water in that of an eicosohedron. The resemblance of this to the formulæ of modern science is merely superficial. Earth, water, and air now represent only conditions of matter—the solid, liquid, and gaseous, not its ultimate constituents, whilst fire is regarded as a form of molecular motion. The Atomic theory of the ancients was purely

theoretical, founded, apparently, upon the character of aggregate masses. In modern science it rests—1, upon the proportions by weight, in which elements and compounds unite; 2, their crystalline forms; 3, the density of vapours; and 4, the quantity of heat which different substances absorb. Aristotle held that matter was infinitely divisible and homogeneous, but capable of assuming different characters, under the influence of "form, nature, and privation;" nature signifying, so far as his obscure definitions on this point are intelligible, inherent laws, or rather principles of action,—the soul of the world.

The MECHANICAL POWERS, or such arrangements of machinery as enable us to interchange distance or velocity for power, were practically known to the ancients to a very great extent; but the true laws of Statics and Dynamics, dependent upon the nature and laws of force, were necessarily imperfect. Archimedes' celebrated boast, Δος που στῶ και την γην κινησω—"Give me a standing point, and I will move the world," shews a knowledge of action and re-action, as well as of Newton's other fundamental laws. He did not know that the earth was already in motion, and that, whilst on its surface, he could not only move this planet, but the entire solar system! By raising a hand, we now know that we can "move the world;"—by walking east or west, we can accelerate or retard its revolutions! His solar lens for burning the Roman ships at the siege of Syracuse, however visionary may have been its practical application,—his discovery of specific gravity, and his geometry, which, as completed by Euclid, still holds its place in our academic studies, prove that in elementary mathematics, both pure and applied, classic Greece has, as yet, produced some of the highest standards. The great advance which was made at the close of the dark ages was the joint product of the ancient methods of mathematical demonstration, and the improvement in optical instruments. Neptune had "long been felt trembling on the long line of our analysis," before the telescope afforded any actual observation. Although now known to be incapable of creating force, mechanism has enabled us to avail ourselves of it, in forms and from sources unknown or inaccessible to the ancients. Force locked up in coal or gunpowder, when developed as heat, and converted into mechanical action, has put into our hands a power which is not only superseding the use, but even the nomenclature of "horse power," "foot-pound" being now the more expressive measure. "This pound of coal," says Professor Tyndall, "which I hold in my hand, produces, by its

combination with oxygen, an amount of heat which, if mechanically applied, would suffice to raise a weight of one hundred pounds to a height of twenty miles above the earth's surface. Conversely, one hundred pounds falling from a height of twenty miles, and striking against the earth, would generate an amount of heat equal to that developed by the combustion of a pound of coal." The strength of the scientific machinery in this country is estimated at not less than that of 100,000,000 men. "Nearly one-sixth of the annual produce of our coal mines," (10,000,000 tons) says Professor Rogers, "is used for the production of mechanical power alone, from which a power equal to that of 66,000,000 men is obtained.

In NATURAL HISTORY—the foundation of Inductive Science—the labours of Aristotle afford a most instructive example. In the midst of his conquests, Alexander supplied ample funds for obtaining specimens; and laying aside metaphysics and the popular philosophy of the schools, Aristotle devoted himself to the study of Nature. "The Greek Philosopher," says Professor Owen, "in zootomical science, had advanced far beyond his systematic depreciator, Bacon, who could not, in fact, in the then state of natural knowledge, comprehend his discoveries. . . . . Such was the state of the philosophical knowledge of animals, in the interval between Aristotle and Cuvier, that there is no similar instance, in the history of science, of the well lit torch gradually growing dimmer, and smouldering through so many generations and centuries, before it was again fanned into brightness, and a clear view regained both of the extent of ancient discovery, and of the true course to be pursued by modern research." In this interval, the Fathers of the Christian Church adopted the Phœnix as a veritable emblem of the Resurrection; and Cæsar, so accurate in his military records, speaks of the unicorn stag, and the goat, which, having no joints in its legs, slept leaning against a tree! The study of nature has been the basis of true science in all ages. Solomon "spoke of trees, from the Cedar of Lebanon to the Hyssop which groweth upon the wall." "Aristotle," says Cuvier, "made thousands of observations of extreme delicacy, the accuracy of which the most vigorous criticism has never been able to impeach;" and Dr. Whewell, in his history of the inductive sciences, affirms that Aristotle "stated, in language much resembling the phraseology of modern schools, that particular facts must be collected, and that from these general principles must be obtained by induction."

In ASTRONOMY, which Aristotle confounds with Meterology, believing that the celestial bodies moved in an ether, a fifth element which surrounded the earth, very little progress had been made. The Sun, as amongst the Jews and all other nations, was supposed to move round the earth, which Aristotle believed to be a globe, but which was ordinarily regarded as a disc, or boundless expanse. The orbits were considered to be circular, instead of elliptical, "because this was the most perfect figure," not as the result of observation; and the stars were regarded as possessing great influence, their proximity to the earth being such that Pliny speaks of honey dew, which we know to be mainly the product of ophides, as *Cæli sudor, sive siderum saliva!*

IN GEOGRAPHY, the *Orbis veteribus cognitus* was a limited area, beyond which all was fabulous, or utterly unknown. Britain, even in the Roman period, was the *ultima Thule: Toto penitus remotos orbe Britannos.* Modern Physical Geography, with the aid of the compass and astronomical science, has now almost reached its limits. The discovery of the sources of the Nile, in Lake Nyanza, and the snowy ranges in Central Africa, has solved the most important problem agitated by Herodotus.

ETHNOLOGY was a still darker science. The earliest records and Egyptian art represent the Negro and the European as identical with the existing races. The Ethiopian has no more changed his skin than the leopard his spots, and Aristotle argued, as confidently, that the inferior races were the natural slaves to Europeans as any Southern planter. The prevalent idea seemed to be, that prior to the earliest migrations—the Pelasgi and the shepherd kings—there were Αυτοχθονες, men sprung from the soil. The ORIGIN OF LANGUAGE was shrouded in the same obscurity. Herodotus mentions experiments which were made, in the hope of ascertaining the primitive tongue, by secluding children from the sound of the human voice. Sacred History, as popularly interpreted, assigns a single origin to the human race, with the miraculous communication of new languages, on the dispersion at Babel. Many able scholars, and firm believers in inspiration, now interpret the first and second chapters of Genesis as consecutive, believing the first to afford a summary of the Creation which preceded even the earliest races of man; the second, or Paradisaical, being a new centre of Creation, which included only the Adamic race and the domesticated animals; that these alone were affected by the Deluge, which was coextensive only with the race to which it was penal, and

which forms the subject of Sacred History. The confusion of tongues would, under this view, have been effected by the miraculous communication of the language of the surrounding tribes, and the oblivion of their own. This would most effectually have led to the dispersion, and removes the objection to the creation of new languages containing, as they do in their earliest forms, fossil words and idioms,—an idea as inadmissible as that rocks were created with petrifactions of prochronic organisms. I know that any solution of these difficulties is still opposed by those who are either exclusively scientific, or theological. "Most sensible men," says the Edinburgh Reviewer, "have, for the last forty or fifty years, been urging that the two records—the Biblical and the Geological—should not be prematurely contrasted, and we cannot but think that the time when this may safely or wisely be done seems nearly as far distant as ever." The statutes of Alma Mater, on the contrary, where I first studied Aristotle, and where natural science is now acquiring its rightful position, enjoin all Professors to "accommodate and attemper Philosophy with Theology." "The study of Theology," adds the present Professor of Modern History (Goldwin Smith), "should be pursued in immediate conjunction with Physical Science and Philosophy, with the conclusions of which it is the most pressing duty of the real Theologian, at the present juncture, to reconcile religion." I am glad to perceive that we are promised a Paper on this interesting subject from a member whose Divinity degree is a voucher for orthodoxy, and who, as a Senior Wrangler, fully possesses the qualification required by Plato, Ουδεις αγεωμετρητος εσειτω.

In Politics, Aristotle is reported to have given a history and analysis of 255 constitutions. As this treatise is lost, I am spared the temptation of transgressing our rules, and the abnormal condition of slavery, which pervaded them all, would have rendered any comparison with our modern system, with its free working class, of very little value. In principle he was a Constitutionalist, but with the one courtly exception in favour of his royal patron, "unless the monarch be a god, or the son of a god!" Although an ardent Reformer, he maintained the Conservative maxim, in regard to revolutionary changes, that "a bad old law sometimes works better than a good new one." In Politics and Social Economy we have a very full record of his views, so far as these questions had then been discussed. He regarded interchange as the main foundation of wealth. Adam Smith

makes it a characteristic of humanity,—"No dog," he says, "was ever known to exchange a bone with another dog!" Aristotle was also well acquainted with its artificial laws. He defines money as "the measure and representative of value," and gives cautions against tampering with it as a standard, which might be read with advantage by those who ask, "What is a pound?" and the transatlantic financiers, who have transgressed his rules by more than cent. per cent. Dr. Arnold states that he knew his "Politics" by heart, and that he found it of daily service in its application to our own time.

Aristotle's "Ethics" are still a standard in our University education. The leading feature is the division of the virtues, or mental faculties, into intellectual and moral: he places happiness in the exercise of the former, and wisely defines the latter as existing in the mean between two extremes, that mean being determined by our special propensities, εν μεσοτητι τη προς ἡμας, "the sins which most easily beset us." Towards "friends" he recognized the Law which Christianity has extended to all mankind—"As we should wish them to behave towards us." The value of all actions he placed in the motive, προαιρεσις, or, as Juvenal subsequently expressed it, *Facti crimen habet peccandi sola voluntas.*

Literature, which may be defined as the record both of science and art, by means of language, had reached a very high development in classic Greece. As the most methodical in construction and grammar, and containing the most sublime and purest models in every branch of composition, Greek still holds the highest place. The Report of the Public Schools Commission has raised the question whether this has not been carried to excess; and in regard to composition in the dead languages, whether in prose or verse, much difference of opinion now exists. It is argued, that although *Græcia capta ferum victorem cepit, at artes, Intulit agresti Latio,* Greek was only studied for the purpose of improving the national language. Cicero expressly recommends this, urging the benefit to be derived from carefully translating the originals into Latin, rather than attempting to compose in a foreign tongue. In the recent debates in Parliament, we have high conflicting authority of noble Etonians in favour of Latin alcaics or Greek hexameters; whilst others urge that modern languages now afford as instructive models, and are of far more practical utility. One thing seems certain, that whatever is worth doing is worth doing well; and that unless the classic languages are learnt with sufficient accuracy

to enable the student to appreciate their beauties of style and expression, the mere facts and prominent ideas can as well be understood from a translation. It is, indeed, only when literature passes into a fine art that it is, for its own sake, of any distinctive value—*ut pictura poesis,*—

> ———— "Creative art,
> Whether the instrument of words we use,
> Or pencil pregnant with celestial hues,"

is only the imitation of nature, although idealized. Take a few sea-pieces—Pope's calm,—

> "Silent he sauntered by the sea-beat shore,"

is as much a picture as Homer's glorious breakers. Βη δ'αχεων παρα θινα πολυφλοισβοιο θαλασσης. Byron's "Dimple on old Ocean's cheek," is only an artistic copy of Æschylus's γελασμα ποντου. Arnold's—

> "Now the wild white horses play;
> Champ and chafe, and toss in the spray;"

the Poet Laureate's—

> "Voice of the long sea-wave as it swells,
> Now and then, in the dim grey morn;"

or,

> "The league-long breaker thundering on the reef."

These only want framing to qualify them for the Royal Academy.

Poetry is, by Aristotle, made the subject of a separate treatise, and, in common with music and painting, entered largely into his system of national education. The theatre was then, as now, a powerful instrument for good or evil, its object being "to purify the feelings by the excitement of pity and indignation." δι' ελεος και θυμου ποιουσα τοιωνδε παθηματων καθαρσιν. Music, which seemed to have had an overpowering influence, was the first to become corrupt. Plato excludes it altogether from his Republic, and Aristotle speaks of the "theatrical transitions, and the tawdry and glaring melodies in use there, as suited to the perversion of their minds and manners, and let them enjoy them." Works of imagination were regarded by Aristotle as "more philosophical than history;" φιλοσοφικωτερον της ιστοριας,—in other words, as the philosophy of history. I call attention to these points, more particularly, in consequence of the interest which is now taken by some Social Reformers in the revival of the drama, as an instrument of popular instruction, and the high posi-

tion accorded to the modern novel. Lord Russell, at the recent anniversary of the Literary Fund Association, speaks in the following terms:—"You all know with what power genius can make you acquainted with imaginary characters; and those persons who have read *Barchester Towers* and *Framley Parsonage*, will entertain the liveliest recollection of the acquaintances they there made. I have read those works with the greatest delight; and if I have not yet been able to make myself acquainted with *the Small House at Allington*, it is because there is a great house in Downing Street which takes up so much of my time. The skill with which our authors of dramas, novels, and romances, impress their fictitious personages upon our minds, is something marvellous. Everyone, I am sure, will find, on reflection, that he is far better acquainted, for example, with *Don Quixote* and *Sancho Panza*, than with *Julius Cæsar* or the *Duke of Marlborough*. Of Shakespeare himself, great as he was, we have no very distinct conception; but of his *Falstaff* and his *Justice Shallow* everybody has a clear idea." The real instruction derivable from fiction is, however, confined to the delineation of individual character, or social usages, which can scarcely be faithfully sketched from real life. The advantage even of this, in historical novels, is questionable, having a tendency to become confounded with authentic facts; and it would be difficult to find any valid plea for the "morbid mental anatomy" of the Sensationalists. Comedy seems never to have been very popular in the classic age, and it is this alone which is prone to degenerate into licentiousness. Aristophanes' language was, indeed, as gross as the farces of the last century; but it was not until a much later age that immorality was made a refined source of pleasurable excitement. Humour was at a very low ebb; bad puns—"a species of wit," growled Johnson, "based upon the imperfections of language"—were amongst the highest efforts. Βαινεν εχων υπο ποσσι χιμετλα, "Beneath his feet were *stinging nettles*" (sandals), is thought worthy of quotation by Aristotle; with Γελα και Καταγελα, "Scilly and Sicily!" and εκ κυματων γαλην ὁρῶ, "Amidst the waves I hear the *sea-mew!*"

From this cursory review of the progress of human knowledge during the past two thousand years, two important questions arise. First, What is the relation which Natural Philosophy bears to Revealed Religion? and, secondly, What has been its influence upon the moral and physical condition of mankind? It is often asserted that Christianity is diametrically opposed to human wisdom, and that when St. Paul

stood on Mars' Hill, he alike condemned the religion of Greece as "superstitious," and its philosophy as "the oppositions of science, falsely so called." If we examine the circumstances more narrowly, we shall find that the schools of philosophy to which he referred were the Stoic and Epicurean, not inductive science founded on the observation of God's laws in nature, which, as we have seen, had already made great advances, and which now alone claims the title of Science. The metaphysical, or subjective method, was always predominant in the Greek mind. Plato distinctly adopted it, in despair of finding truth in external phenomena. "It seems to me, therefore," he says in the Phædo, "that I ought to have recourse to reasons, and in them to contemplate the truth of things. Thus always adducing the reason which I judge to be strongest, I pronounce that to be true which appears to me to accord with it: those which do not accord with it, I deny to be true. . . . . . I cannot conceive that any science makes the soul look upwards, unless it has to do with the real and invisible. It makes no difference whether a person stares stupidly at the sky, or looks with half-shut eyes upon the ground; so long as he is trying to study any sensible object, I deny that he can be said to have studied anything, because no object of sense admits of scientific treatment." This sufficiently explains the strictures of St. Paul upon the current philosophy, when, alike rejecting revelation and nature, "all the Athenians and the strangers which were there spent their time in nothing else, but either to tell or to hear some new thing," in the visionary regions of speculative metaphysics. Religion without evidence is superstition,—evidence without faith, culpable infidelity. St. Paul, therefore, met their worship of the unknown God—a religion of servile fear, as the word signifies in the original—with the direct revelations of inspiration. In his Epistle to the Romans, he referred to God's works in nature. "The invisible things of Him from the creation of the world are clearly seen, being understood by the things which are made, even His eternal power and Godhead." At the same time he makes great use of sound metaphysical reasoning, insisting that "they which are without law are a law unto themselves, which shew the work of the law in their hearts, their conscience also bearing witness, and their thoughts the meanwhile accusing or else excusing one another." Law might have been, as some modern heathens still maintain, an innate self-acting principle. Revelation tells us it is the action of Deity. This reconciles every difficulty in regard to miracles

and providence. One is the orderly course of divine operations, in an unbroken series of secondary causes and effects; the other is the suspension of the law for special purposes. *Nec deus intersit nisi dignus vindice nodus.*

Without transgressing the limits assigned to our discussions, I may be permitted to add one caution. The present order of Nature must not be regarded as the unfallen transcript of the Divine mind. It was the difficulties connected with this which drove Plato into metaphysics. Aristotle clearly recognized the existence of evil, and assigned it to the imperfections of matter; whilst, in his ethics, he almost anticipated St. Paul in the graphic delineation of "the law in the members warring against the law of the mind." *Video meliora proboque, deteriora sequor.* This truth is too often overlooked by natural Theologians. "Teeth," says Paley, "are contrived to eat, not to ache; their aching, now and then, is incidental to the contrivance, perhaps inseparable from it, or even, if you will, let it be called a defect of the contrivance." "We have a right," says his commentator, Lord Brougham, "to impute the perception of any evil at all to our own ignorance, and to conclude that, if we knew the whole system, and could extend our comprehension to the entire plan of creation, we should no longer believe that there was any evil at all." I prefer the creed of Aristotle and St. Paul.

One of the most conclusive evidences of Natural Religion, to which sufficient prominence has not been given, is the existence of Beauty. Blind, indeed, must be the student of nature who fails to discover its presence, not as an accident, but an essential element in the whole system of creation. Aristotle was the first to point out its importance as a branch of study, making drawing, in his Politics, a branch of national education. He urges the necessity of becoming acquainted with its laws, if we would rightly appreciate or feel its influence.

> "A primrose by the river's brim,
> A yellow primrose was to him,
> And it was nothing more."

Wordsworth's rustic still represents a large class, even of otherwise well educated minds. The rigid botanist might, perhaps, retort that the *habitat* of the *Primula veris* is never within reach of what Tennyson calls the "brimming river;" but poetry, like painting, has its Platonic idea—an abstract essence of nature, near enough to truth for its own purposes; and, as Ruskin maintains in regard to conventional mediæval art, sometimes more effective than literal truth. An eminent

poet, who formerly resided at Livermead, passed the lime avenues and elms of Tor Abbey daily, yet writes of them as oaks!

> "Casual bricks in airy clime
> Met casual sand and casual lime,"

and so, in the Hudibrastic parody, the world was built; but would any mathematician accept this as the true doctrine of chances? Uniform averages are the necessary result of a long series—no fortuitous concourse of atoms would have produced anything but a dead level, and a mean neutral tint! Accidental forms, capable of reproduction, might, by a great stretch of the imagination, have been perpetuated, but beauty would never have entered into these; the organization of the anthers and pistils bear no discoverable relation to the colour and form of the petals; and no Darwinian doctrine of selection could preserve the purity of design in the bird or butterfly without a law, the highest evidence of a law-maker. Pliny remarked that no one notices the sun or moon, unless when they are eclipsed "*Sol spectatorem, nisi cum deficit, nullum habet, Nemo, adspicit lunam nisi deficientem,*" and the most marvellous phenomena in ordinary nature pass unheeded. Take a feather, a flower, or an insect,—if merely painted after it was formed, it would afford ample evidence of design; but, if we watch its growth, we shall find that each separate portion is designed before its full development, so that when the whole is combined, each particle of line and colour fits into its place, and forms a harmonious whole, like the particoloured thread which forms the pattern as the shuttle passes.

In regard to the second question, whether our moral and material progress has kept pace with these great advances in knowledge and power, there is much to afford encouragement; but, at the same time, much which still remains to be done. The necessaries of life are now within the reach of all; famine and pestilence have, in great measure, yielded to the growing power available to human industry, and the clearer knowledge of commercial and sanitary laws. War has lost some of its horrors—

> *Ἑις οιωνος αριστος, αμυνεσθαι περι πατρας.*

> "His sword the brave man draws,
> And knows no omen but his country's cause:"

and

> "*Parcere subjectis et debellare superbos,*"—

the maxims of Greece and Rome, regardless of a good or bad cause, are now, professedly at least, subjected to a national

conscience. The professed basis of the Holy Alliance was, that "the sole rule of their conduct, as well in the administration of their respective states as in their political relations with every other Government, should be the precepts of their holy religion—precepts of Justice, Charity, and Peace." "To put an end to that slaughtering policy which, under the mask of order and legality, dominates the world," is the programme of Garibaldi; and the *odium theologicum*, as defined even by St. Augustine, "The enemy to be hated is the sinner, as the enemy of God," has yielded, in some measure, to the true spirit of Christianity. In this country, the duties of an international police are regarded as the utmost limits of those who would "bear not the sword in vain." Still, there are fearful exceptions. The thanksgiving of German despots, and the prayer of American democracy, are equally heterodox in religion and philosophy. "We pray thee," says the Federal chaplain, "that if it should be thy will, even the processes of physical nature may be suspended for a time, while the fearful problem of republican liberty and free institutions is wrought out." The best features of the citizen soldiery of Greece and Rome are represented by our Volunteers. "To my mind," says the Inspector-General, "the Volunteer should be a sober-minded, God-fearing man, earnest and determined to *defend* his country;" whilst, in regard to military qualities, in common with his professional brethren, we shall, I hope, all concur in the estimate of Sir Walter Raleigh: "If I were asked which makes the best soldier, a Greek or a Roman, I should say—an Englishman!" The greatest advance which has been made in the present century, is the abandonment of duelling. England has first, and alone, fully adopted the principle, and with a success which reflects the highest credit upon our national character.

If we look on the other side of the picture, nearly a million of paupers (974,364, 31st March, 1864), of whom 125,000 are in our workhouses, 11,000 houseless poor, and 23,000 in charitable institutions, prove not only that "the poor shall never cease out of the land," but shews something still radically wrong in our laws and social habits. 26,000 criminals in prison is a disgrace to our religion and morality; whilst the tenants of lunatic asylums, now numbering 24,000, and the average years of man, far below the three score years and ten, afford much ground for improvement. There are no statistics sufficiently in detail to enable us to form a comparison between the condition of the population now and at the period which we have been considering; but it is obvious that, even if we deduct the

slave element, the condition of the humblest classes of society has made considerable progress. Experience and theory alike point to the freedom from artificial restrictions, and the natural laws which regulate social intercourse as the most successful means of improvement. Man cannot benefit himself by any honest arts or industry without benefiting his neighbour. This is now recognized in law; but is it fully admitted and acted upon by society? Much well-meaning ignorance and social bondage still check our progress, even in self-indulgences. Expenditure and style of living are not regulated by our own desires, but the pressure of fashion and opinion; and a false political economy flatters us with the idea that it is all for the good of trade and industry. I shall, I fear, be considered to take an exaggerated view, if I assert that the greatest impediment to the attainment of a higher civilization has been the discovery of distillation, and the use of stimulants and narcotics. What opium has been to China, and tobacco to the Turks, alcohol is to us. In the language of the venerable Recorder of Birmingham, "The drink-demon stands up and stops the way!" I will not burden you with statistics, but am prepared to prove, from the returns of insurance offices and friendly societies, with twenty years' personal experience of total abstinence, that one-third of the mortality, nearly half the sickness, and a very large proportion of the crime, pauperism, and lunacy which afflict this country may be traced to this single cause, upon which £80,000,000 is annually expended, in addition to the vast indirect losses which are entailed upon all classes of the community. Social Science, as was well observed by my predecessor, is one of the main objects of this Association. Time will not admit of my going into details, but I must congratulate its advocates upon the general tenor of modern legislation and public opinion. An improved system of friendly societies, with the new Government Annuities; Savings Banks, now rendered secure and accessible to all by the agency of the Post-office; and the limitation of the hours of labour to those who are unable to protect themselves, are all steps in the right direction; but the most prominent feature is Limited Liability, which, whilst it enables the humblest investor to compete with the millionaire, protects him from the liabilities of his co-partners. Co-operative Societies and Stores are spreading widely amongst the poor, by which they obtain supplies nearly at wholesale prices, with freehold houses and land through Building Societies, by the accumulation of profits on the ordinary rents, being their own tenants. In addition to these direct pecuniary advantages,

there is the spirit of industry, providence, and self-reliance—the foundation of all true national prosperity and greatness.

The advances which have been made during the past year have been rather in practical details than in any startling discoveries. Amongst the more prominent, I may very briefly mention the following:—

The estimates of the distance, and, consequently, the size, of the sun and other bodies in ASTRONOMY, have been considerably modified by recent observations with revolving mirrors, and confirmed by more accurate mathematical calculations, as also, in some degree, by Mr. Glaisher's discovery of the true law of diminution of humidity and temperature in the higher regions of the atmosphere which affects refraction. The rapidity of light, according to Bradley's method, was estimated to be at the rate of 191,513 miles in a second, and by Römer's observations of Jupiter's satellites, 192,000. It is now reduced by about 6000 miles per second.

A most interesting series of lectures on AËROLITES has been delivered by Mr. Alexander Herschell, of the Royal Institution. The structure of meteorolites closely resembles that of our volcanic rocks, yet is actually distinct from them. In their composition, twenty-four elements have been found, the principal being iron and its oxides, magnesia, and silica. The facts recorded of them seem to point to the local convulsion of a large planet for their origin, or the disruption of a small one. There is no planet where the rigidity of iron is so discernible as in the volcanic precipices of the moon; but "the ballistic theory," says Mr. Herschell, "requires very exaggerated views of the molecular forces which were formerly in operation. If we assume these, we may assume that the earth scattered aërolites along its path. This is the wandering matter which Le Verrier calculates to be as large as the mean distance of the earth from the sun, and a similar quantity between the sun and Mercury." A very interesting subject of inquiry has arisen from the discovery of a hydrocarbon, akin to lignite, in some meteoric stones, which is supposed to prove an organic origin; recent advances in synthetical chemistry, however, seem to shew that such combinations do not necessarily imply either animal or vegetable life.

In ELECTRICITY no great progress has been made. I have only space to give the following communication from Mr. Jonathan Hearder, in regard to the confirmation of the views expressed in a very instructive paper which he read at our last meeting:—"The splendid parish church at West Darby,

near Liverpool—a new building, quite in cathedral style, and having a tower with four turrets, one of them higher than the rest—was furnished with a lightning-conductor, fixed in the way which I have deprecated; viz., against one of the turrets only, leading from thence to the ground. As if to make the matter worse, the turret selected for the conductor was not the tall one, but one of the short ones. On the top of the tower, also, was a flag-staff, higher than either of the turrets. During a thunderstorm which occurred on the afternoon of Sunday, the 5th or 12th of June, the lightning struck the spindle of the tallest turret, passing down through the masonry, and shattering it to the base of the turret. It then passed along by the lead to the one which had the lightning-conductor, and made a hole out through the masonry to get at it, after which it passed harmlessly to the ground. Now, had each of the turrets on this tower, as well as the flag-staff, been furnished with a lightning-conductor, and had these conductors been all connected together into one common channel, this damage might have been prevented. The accident affords an additional proof that a conductor protects but a very limited area around itself, and is simply a conductor, and not an attractor."

In MAGNETISM, Joule's experiment, which shewed that when a bar of soft iron is magnetized, it is elongated and a sound produced, due to the vibration of the particles, has been further elucidated by Professor Tyndall. By strewing iron filings upon paper placed over a powerful magnet, he exhibited the magnetic curves, or lines of force, and suggested that the elongation of the bar of iron was probably due to its particles setting their longest dimensions parallel to these lines. This result had not yet been produced in a dia-magnetic body by the supposed antagonistic force.

The EARTHQUAKE, which occurred on the 6th of last October, is discussed in two very interesting papers communicated by Mr. Griffin and Mr. E. J. Lowe to the Meteorological Society. The former describes his own sensations as rolled eastward by the shock, and proposes as a theory, that gases imprisoned in cavities between the earth's crust and its molten interior are suddenly liberated. Mr. Lowe defines the area over which the earthquake was felt as "extending north as far as Doncaster, Huddersfield, and Clitheroe; east, as far as Peterborough and Bedford; south, to London, Dorchester, and Plymouth; and in the west, crossing the St. George's Channel, to Dublin and Wexford. It was also felt in a few isolated places,—Lancaster, Ulverston, Harrogate, Malton,

Scarborough, Bury St. Edmunds, Brighton, and the Isle of Wight. A line drawn from Stafford to Cardiff would pass through the localities of greatest intensity. The focus of the shock must have been at great depth, as it was felt almost simultaneously throughout England and Wales; whilst, had it been near the surface, it would have occupied eight or ten minutes in travelling to some of the places. The discrepancies in its estimated duration are probably owing to the vertical predominating over the horizontal movement. Near the centre of the concussion the explosion occurred immediately after the shock, but in more distant places the noise was heard to *precede* the shock, owing to the much more rapid velocity of the *sound-wave* over that of the *earth-wave.* It is now certain that there were several shocks, the two most severe close together at 3·23 a.m.; the less violent ones being felt at 2·25, 3·10, and 4 a.m. He gives a tabulated series of observations from more than 200 stations. The most violent motion was felt in Herefordshire, where "an extraordinary sound was heard approaching from the west, accompanied by a violent shaking of the earth; the noise was a rapid succession of detonations, not loud in its approach, but, in an instant, equalling thunder, and then, in a moment, dying away; with the crash was felt a fearful lift from beneath, directly upwards. Many bells rang, some walls and ceilings were cracked, china and glass were broken, and the trees shook violently, although the air was calm. At Stretton Rectory, Mr. Key describes the crash as being equal to the loudest peal of thunder, yet fuller, deeper, and grander. At Hampton House, near Hereford, Mr. Weare, who is an astronomer, was sitting facing the west, when up went the leg of his chair, and he distinctly felt the shock in his left leg before the right was affected; for, although instantaneous, it was appreciable." He gives a very interesting abstract of earthquakes which had been previously felt in this country. Within the present century, no less than 110 had occurred in the British Islands; in 1134, flames issued from the earth in Kent; Glastonbury Church was thrown down in 1328; in Herefordshire, in 1571, Moreley Hill (26 acres in extent,) was removed; 100 houses and five churches were destroyed in Ireland in 1703. The most recent were in 1853 and 1854. In this town I distinctly felt the shock, and having first dreamt of falling with a church tower, then upon the trees in front of my house, and still hearing the glass jingle distinctly, after I was awake, either my dreams were more rapid than Lord Brougham's celebrated visions, or there must have

been a succession of shocks. In 1854 an earthquake, described by Mr. Ormerod, hon. secretary of the Teign Naturalists' Society, was mainly confined to the granite of Dartmoor. The earthquake last year followed the trappean dykes; the rock on which Exeter Castle stands is said to have left a crack where it vibrated against the surrounding formations. May not the present have some connection with these antient lines of force? Mr. Lowe, in a letter to the *Times*, dated 4th June last, says—"My earthquake pendulum, on the evening of the 29th ult., registered a sensible movement of the earth from W.N.W. to E.S.E., and from 11 p.m. until 1 p.m. on the following day, there was an almost constant movement of the earth, although very slight." On the 1st June he records the temperature on the grass as 31° 1, whilst only a few days before it had been up to 89°.

In Geology and early Human Antiquities there have been many most interesting discoveries during the past year. The most important are in a Bone Cave in Gibraltar, also in central France, principally in the department of the Dordogne, by M. Lartet and M. Christy. Dr. Falconer has published a notice of these, describing some marvellous specimens of primæval art. "The most remarkable," he says, "is a long dagger, formed out of a single horn. The handle represents the body of a reindeer, the parts in fair proportion, and treated with singular skill and art-feeling, in subservience to the purpose for which it was intended. The fore legs are folded easily under the body, the hind legs drawn out insensibly into the blade, the salient horns and ears are cleverly applied to the chest, by giving an upward bend to the head; and a convenient hollow, for the grip of the hand, is produced by a continuous curve extending from the rump to the muzzle. M. Lartet remarks that the hand for which it was designed must have been much smaller than those of the existing European races. The weapon was evidently left by the artist savage unfinished; but, as a design embued with taste, it will bear a very favourable comparison with Oriental dagger-handles cut in ivory. . . . . In forming an estimate of the value of these relics of art, the reader will bear in mind that they are the productions of the unpolished and unground "stone period," the tools employed having been thin chips and delicate flakes of flint; such, at least, is the fair inference drawn from the negative evidence,—not a trace of metal, in any shape, having been met with in the Dordogne Caves." A valuable series from Bruniquel, in the south of France, has just been acquired by the British Museum, which

I have seen. The head and horns of the rein-deer are very spiritedly graved, in outline, upon flat pieces of bone. The latest discovery is in some caves at Chaffand on the Clarente, near La Rochelle. M. Brouillet reports not only arrow-heads in abundance, but bones made into rude needles, with traces of ornamentation, the sun and moon being represented as well as animals. Further discoveries are announced in the German as well as the Swiss Lakes. Upon these I propose to read a separate paper.

In Meteorology, Mr. Glaisher's discoveries form quite an epoch in the science. Their bearing upon astronomical observations has been already noticed. His law of the diminution of vapour at higher altitudes fully bears out an observation which I made in a balloon ascent many years ago, and communicated to the *Athenæum*. Professor Tyndall's investigations of the interception of heat by even invisible aqueous vapour, is the first explanation of the absence of dew on a fine night being a prognostication of rain.

The value of Weather Forecasts has been warmly canvassed by Admiral Fitzroy and Mr. Smith, M.P.; facts and figures proving proverbially deceptive when adduced to support opposing theories. The Wreck-Chart is claimed as evidence on both sides, which may probably be accounted for by the fickle attention which is paid by sailors to the Admiral's cone and drum. The curves published by the Admiralty, shewing their correspondence with actual results, are very encouraging.

Photography has made some remarkable advances during the past year. Photo-sculpture has connected sun-painting with the sister art, and promises, both in economy and accuracy, to produce important results. The following is the process. A series of outlines (generally about 20) are taken simultaneously, by cameras placed around the sitter, shewing the exact outlines, either of bust or whole length, from every point of view. These are then projected on a larger scale upon a screen, and, by means of a Pantograph carrying a blade, the several outlines are cut upon the clay. The intervals between these are finished by the artist with the ordinary instruments, and the model is then complete. Instantaneous portraits of animals or children may thus be taken with the most lifelike accuracy, the finishing touches of expression and texture being given by the sculptor. Another great discovery is the application of the Magnesium Light to Photography, by night, or in the interior of dark buildings and caverns. In the combustion of this metalloid, the amount of actinism

or chemical ray evolved, in proportion to the light, is stated to be about three times that of the sunbeam. This enables the eye to bear a much higher power, and, by an artistic arrangement of secondary lights, affords an opening for composition and high art, which has hitherto been unattainable. The magnesium wire burns in ordinary atmospheric air without any objectionable effluvium.

At our first annual meeting, a subject of much social as well as scientific interest was brought before the Association by the President, to whose parliamentary exertions the first step which has yet been taken in remodelling our currency is due. I refer to the DECIMAL COINAGE. The advantages of assimilating our weights and measures to our arithmetic, and the adoption of the same standards throughout the world cannot be over-stated. The strength of the objections rests in the *vis inertiæ* of established usage, as, in adopting a new system, the practised accountant reduces himself even below the level of the new beginner. The facility with which the merchant, the engineer, the stockbroker, and the frequenters of agricultural markets, with their cumbrous, ever-varying provincial standards, perform their mental arithmetic would not willingly be exchanged for any new system, however theoretically perfect. Like the registration of titles, or any similar social reform, the present staff of professionals would be unequal to the labour of effecting the transition, which, by reducing the demand for their services, would eventually prove suicidal. The chief objection to a decimal system is the original adoption of 10 as the terminal. The octaval system is almost universally adopted in practice, "a perpetual halving," as Lord Overstone expressed it in his recent evidence, being the most simple, and aliquot parts the arithmetical process most readily available, both in mental and mechanical operations. Our mile is divided into furlongs, the draper's yard into nails, and the capenter's inch into 8ths. The stockbroker rejects the florin for his old scale of half-crowns; and pints, quarts, and gallons are far easier of comprehension than decimals. Octaval arithmetic requires only 64 combinations, whilst the decimal has 100; the duodecimal, which some have advocated as offering greater facilities for division, would require 144. Of terminal numbers, 8, as 8, 4, 2, 1, has obvious advantages over 10, 5, 2½; 12, 6, 3, 1½; or any other number not reducible to a unit. Such a revolution as a change in our arithmetic would, however, be too great a sacrifice to ask of any generation, and the practical question seems to be resolved into this,—whether octaval weights and measures,

although incommensurable with our decimal arithmetic, are not preferable to an harmonious but less convenient scale. By an Act passed in the present session, the adoption of the metrical system is made permissive, and there seems to be a very general impression that our coins might, without serious inconvenience, be reduced to decimals. Sir John Herschel has recently raised the question of the unit to be adopted, arguing, in "the battle of the standards," that "the British system refers itself with quite as much arithmetical simplicity, through the medium of the INCH, to the length of the earth's polar axis (a unit common to all nations), as the French does through that of the *metre* to the elliptic quadrant of a meridian passing through Paris,—a unit peculiar to France.

I would urge the special importance of the study and careful record of the facts of NATURAL HISTORY at the present juncture. The encroachment of man upon nature is rapidly obliterating some of the most important evidence, both in regard to natural agencies and his own early history. Geology, which is rather the universal record of nature, than a specific branch of science, may, perhaps, always have materials for tracing the leading features of the past; but the present condition and geographical distribution both of the Fauna and Flora, upon which the solution of many of the most interesting problems depends, are undergoing such extensive modifications, and the few links which still exist between Geology and human antiquities are so obscure and fragile, that in a few centuries all original traces will be lost, and philosophy will have to rely upon the present race of observers for its facts. Such theories, for instance, as Darwin's Origin of Species, Forbes's Centres of Creation, or the migration of primitive types, will never again have a virgin continent on which to test their conclusions. Every cavern and barrow will have been ransacked, the domesticated varieties, both of plants and animals, will have largely supplanted their wild prototypes, and man himself, all but the dominant races, will have been civilized off the face of the earth. The change is already in progress—the Marsupials, the highest type which appeared indigenous to Australia, and recalled, in imagination at least, the Oolitic age of Europe, are being rapidly superseded by the importation of higher genera; English weeds, led by the *noli me tangere* of an enthusiastic North Briton, are marching as conquerors across the Southern Continent. The small bird controversy is carrying its point by peopling the Antipodes with the sparrow and the thrush; salmon ova are now telegraphed as shewing life in the breed-

ing-ponds of Tasmania; and Cape plants, found in the wilds of New Zealand, will soon confound all traces of local development. It is noticed, as a remarkable confirmation of the claim to higher antiquity of the European Continent, that with, perhaps, the solitary exception of a North American water-plant, which has taken possession of our rivers, no foreign importations can fight their way against Britons. The Asiatic pheasant needs the protection of the gamekeeper, and if the husbandman or the gardener relax his vigilance, we all know how soon the battle for life would give victory to native energy. Under our own eye we have interlopers, as the edible snail found at the Roman stations in this country, and the microscopic shells, supposed to be Mediterranean species, recently dredged up in Torbay. In South America, the horse of the Spanish colonists, having again become wild, renders it very difficult to account for the extirpation of the fossil equus. In Ethnology and the history of language, a careful record is still more essential. Intermarriage, ordinarily regarded as a test of unity of origin, may, in the human family, be subject to exception, which the infertility of the purer races seems rather to confirm. If so, the results inevitably destroy the evidence; whilst, in regard to language, the tendency both to division and aggregation renders the question of origin, from internal evidence, increasingly difficult.

I have now only to thank you for the kind attention which you have given to these remarks. I present them merely as crude notes, having been interrupted in their compilation, though very pleasantly, by an invitation to accompany Professor Phillips and an antiquarian friend in the exploration of the antient Swiss Lake dwellings and the Glaciers. I hope to make amends, by submitting to you to-morrow some of the results.

In conclusion, I must appeal, in the language of Professor Owen, to "the merchants of Light," prefigured by Lord Bacon in his New Atlantis, who have honoured us with their presence at this meeting,—"We only provide the mart; you must yourselves provide the merchandize."

THE

INTRODUCTION OF CAVERN ACCUMULATIONS.

BY WM. PENGELLY, F.R.S., F.G.S., ETC.

Introduction.—Amongst the various problems connected with caverns stands that of the introduction of their accumulations.

Caverns differ much in their phenomena: the history of one is certainly not the history of all. Unless I have much misunderstood the facts that have fallen under my notice, Devonshire contains caverns which, respecting the modes in which their contents were introduced, may be divided into four classes; water in motion, however, being indispensable in all cases.

Amongst the numerous caverns in various parts of this county, I know of none which does not contain clear evidence that water performed an important part in its formation; it would be unsafe, however, to infer from this fact, that it was necessarily filled by the agency of water also. The evidence as to the mode of introduction must be sought in the deposits themselves. In some instances, at least, the existing contents of caverns were carried in long after the excavation had been completed. The famous Windmill Hill Cavern at Brixham, for example, had certainly been twice filled and emptied before the introduction of that mass of materials which was found in it and systematically excavated in 1858. This fact is of so much interest that I may, perhaps, be allowed to state, very briefly, the evidence on which it rests. With the exception of two unimportant and very local beds, the cave deposits in the principal gallery were, in descending order, as shown in Fig. I.

1. Stalagmite floor (*b*), containing bones of extinct and recent animals.

2. Cave-breccia (*c*), consisting of reddish loam, angular and rounded stones, bones of extinct and recent animals, and

containing flint implements. This was sometimes called the "Bone-bed."

3. Gravel (*d*), almost entirely destitute of organic remains.

Above the floor of stalagmite there were from three to five feet of open space (*e*); but the roof—more correctly the ceiling—instead of being the limestone rock, was a cake of stalagmite (*a*), extending horizontally, from wall to wall, across the gallery. It was unmistakeably a floor of higher antiquity than that (*b*) beneath it, and had been formed on an accumulation which had been swept out prior to the introduction of that (*c*) which occupied the cavern when it was discovered in 1858. Moreover, there were found clinging to the nether surface of this old floor numerous angular, subangular, and rounded stones (*i*), remnants of the old deposit, which, as has just been stated, had been swept out. Now, a large number of these stones, both angular and rounded, were found to be pieces of stalagmite—fragments of a still older floor, a floor of the third order of antiquity, a floor which had covered a deposit still more ancient. We are, therefore, taken back to a period when the cavern was occupied by deposits covered with a floor of stalagmite; these deposits were ejected, and the floor which had protected them broken up. The cavern was then filled a second time, and the accumulation, in which were numerous fragments of the first floor, many of them being well rounded, was, like the first, covered with stalagmite. Again the deposits were swept out, but much of the floor was left *in situ*, having relics of its predecessor attached to its inferior surface. A third time detrital matter was carried in, and covered with a cake of stalagmite, but at a lower level than the preceding floor. These occupied the cavern when it was discovered. It must be obvious that accumulations of still higher antiquity may have existed and perished.

Introduction of Accumulations through Vertical Openings communicating with the Surface.—The quarrying operations so extensively carried on in the limestone of Oreston, to supply material for the Plymouth breakwater, disclosed, from 1816 to 1822, several bone-caverns, which were described in a series of papers by Mr. Whidbey, who more than once stated that he saw no possibility of the cavern having had any external communication through the rock in which it was inclosed. In the autumn of 1858 a new cavern was discovered at Oreston, and though, before I had an opportunity of seeing it, much of it had been destroyed by the workmen, I was induced to believe that all the caverns which had been

met with there had been so many enlarged portious of one and the same original line of fracture, and was convinced that the materials found in the new cavern had been introduced through an opening originally communicating with the surface. The cavern may be described as an almost vertical fissure, extending for about ninety feet from N.N.E. to S.S.W. Its dimensions and general character are shown in the cross section, Fig. II.

(*a.*) Eight feet high is the roof of the cavern, consisting of large angular masses of limestone cemented with carbonate of lime.

(*b.*) Eight feet; angular fragments of limestone, mixed with a comparatively small amount of sand. The limestone *débris* varied in size from that of hazel nuts to pieces ten pounds in weight. This accumulation was entirely uncemented, and contained no fossils; it was termed "gravel" by the workmen.

(*d.*) Thirty-two feet; tough, dark, unctuous clay, sand, fragments of limestone, and bones of recent and extinct animals; the whole quite uncemented.

(*c.*) Thirty-two feet high and from two to three feet thick; stalagmite, with occasional masses of limestone breccia, the whole containing bones. This was known as "callis" by the workmen. It occurred on one, the western, wall of the fissure only.

(*e.*) Twelve feet, and probably much more, as the floor of the fissure was not reached; dark, very tough, unctuous clay; it contained a few very small pieces of limestone, but no fossils.

It will be observed that *d c* was the bone-bed; that is to say, bones were found in the "callis," and in the adjacent mass of heterogeneous materials; they occurred alike at high and low levels, in the lumps of breccia, in the pure stalagmite between them, and in the incoherent portion of the accumulation; thereby suggesting that the fissure was slowly and gradually filled with *débris* detached from the adjacent limestone, with sand transported from some distance, and with mud; not each in definitely successive periods, but together, with occasional pauses or periods of cessation; the proof of such pauses being seen in the frequent occurrence of portions of pure white stalagmite separating masses of breccia, consisting of limestone fragments, clay and sand, and lying one above another in the same nearly vertical plane. The rapidity of the work of accumulation, and hence the time required for the process, seem of necessity to be measured by the rate of the formation of the stalagmite. It appears, too, that throughout the entire period required for, and represented

by, the accumulation of the bone-bed—alike during the periods of active and of tardy accumulation—bones of various animals were introduced; there could have been no marked suspension of this part of the work, since the bones were found as frequently in the pure stalagmite as elsewhere.

Like Mr. Whidbey, the workmen most positively asserted that the cavern had never been an open fissure, but that the "roof" was of sound unbroken limestone, and that, therefore, the deposits could never have fallen, or been washed in from above. Unfortunately, they as positively asserted that there was no external opening whatever—vertical, terminal, or lateral; and they inclined to the opinion that the rock had grown round the accumulation it contained.

Though a great part of the "roof" had been destroyed before my visit, a sufficient portion remained to show its true character. It was an unmistakeable mass of limestone breccia, made up of large fragments cemented with carbonate of lime, and easily enough mistaken for ordinary limestone traversed by numerous irregular and coarse veins. On the attention of the workmen being called to the proofs of its origin, they offered no other objection than that it required blasting quite as much as the limestone in any other part of the quarry. Throughout the entire length of the "roof" there must have been a line of fracture, as, wherever it had been removed, a soil-stained wall extended from the cavern upwards to the surface of the hill, and distinctly showed that water, plentifully charged with mud, had had free access into the cavern from above. There appears ample reason, then, for believing that the cavern originally communicated with the surface by an opening sufficiently wide to allow the admission of all its contents, and that it was thus filled; but whether the animals fell or were dragged in, or whether the bones found there were, wholly or partially, the disjoined remains of dead animals which were washed in, cannot be determined.

It cannot be necessary to remark that the process by which the Oreston Caverns were filled is not of universal application; nevertheless, the case is by no means unique. A vertical dike of osseous breccia was, early in 1861, laid bare by the workmen at Bench Quarry, in the north side of Furzeham Hill, at Brixham. It had a north and south direction, was about twenty-seven feet high, twelve feet long, two feet thick at the eastern end, and thinned out at the western. Its summit reached the level of the unquarried surface of the hill-side, so that there was nothing having the character of

a roof. It was made up of reddish clayey earth with angular pieces of limestone, from the merest fragments to slabs a foot square and six inches thick, and evidently derived from the adjacent rock. Bones of the ordinary cave animals were extremely abundant, and in excellent preservation. There were indications that this dike occupied a portion of a fissure which in some parts of its course had been developed into a considerable cavern, and that this had been filled through the channel which the dike subsequently occupied.

The quarrymen have recently disclosed in the hill immediately behind the Friends' meeting-house, Warren Road, Torquay, a dike of ochreous earth and stones. It extends from the base to the summit of the quarry section, and underlies towards E.S.E. at an angle of 40 degrees. Measured along its inclination, its height is upwards of 140 feet, its thickness varies from one to four feet, and is least at the top of the cliff. This, too, must have been formed of materials which have fallen or been washed in from above.

The numerous rents and fissures which traverse Daddy's Plain, Torquay, and also the hills between Anstey's Cove and Babbacombe, belong to the same class, and afford much valuable information. They are, if the expression may be pardoned, roofless caverns caught in the very act of receiving accumulations. In some of them, as near Anstey's Cove, the operation has nearly reached completion; whilst in Daddy's Hole the work has manifestly gone on very tardily: the chance-sown ash trees growing there in the soil which has been introduced have attained considerable dimensions; indeed their tops had reached the level of the plain before the recollection of any one now living. Their rate of growth has greatly outstripped the increase of the deposit. Since the germination of the seed from which they sprang, their existence has not been endangered by the too rapid arrival of *débris*.

A small cavern or cell, clearly communicating with the upper surface through a vertical fissure, was, not long since, broken into by the quarrymen at Wall's Hill, between Torquay and Babbacombe. It was partly filled with earth, sand, and stones, many of the last being well rounded and certainly not derivable from the hill in which the cave occurs. The entrance of the materials had clearly been downwards through the vertical fissure already mentioned, as this too was occupied by precisely similar *débris* which was in unbroken connection with the contents of the cave. (See Fig. IV.)

The foregoing examples fully illustrate one mode by which caverns have received their accumulations.

Introduction of Accumulations by Engulphed Streams.—The celebrated Brixham Cavern consists of a series of galleries having the directions of the two systems of joints which pervade the Devonian rocks of the district; indeed some of them are obviously what are known as fissure galleries. Their roof-joints (*g.* Fig. I.), however, are so close-fitting as to allow the descent through them of water only, hence it is impossible that the deposits could have been introduced in the same manner as at Oreston. This fact, however, presents no difficulty in deciphering the history of the cavern, since it has four external horizontal entrances in the slopes of the hill in which it is situated. The arrangement of the materials, too, was such as to show most satisfactorily the mode by which they were brought in. With a remarkable exception in one part of the cavern, every unequiaxed bone and stone lay with its longest axis in the plane of the deposit, and the shortest at right angles to it, thus securing the lowest possible position for its centre of gravity, and offering the least possible resistance to running water; the arrangement being, in fact, precisely that which would result from the action of a stream flowing constantly in one direction, but not such as would be produced by the variable action of the sea. It is no doubt true, that on an *open* beach waves arrange materials very much in the manner just described; but not in confined spaces at all resembling a cavern gallery. On examining a patch of beach occupying a narrow rift between rocks, it will commonly be found, that though the stones may have the form most favourable to it, they seldom assume a horizontal position; even thin ellipsoidal fragments of slate are generally wedged together with their longest axes approximately vertical; in fact, so disposed as if to pack the greatest number in a given horizontal extent, notwithstanding that they thereby offer the maximum of resistance to the action of the waves.

Judging from the inclination of the beds of deposit, it appears that water entered through each of the four external openings, and, after flowing almost horizontally, was discharged through a highly-inclined shaft within the cavern between the two principal entrances. The characters of the walls of this shaft are in harmony with this hypothesis; they are polished and scratched as if by the long-continued action of running water charged with detritus. It will be obvious that this position is only tenable on the supposition that the entrances and galleries were then, as now, above the sea level; or, in other words, that the deposits were intro-

duced by fresh water, not by the sea; a conclusion to which the arrangement of the materials has also led us.

I have stated that in one part of the cavern unequiaxed objects did not lie with their longest axes in the plane of the deposit. This fact, however, will be found strongly confirmatory of the view now advocated. The excepted locality is immediately within and below the most important of the two principal entrances. (See *a*, Fig. III.) The base (*b*) of this opening is a mass of limestone *in situ*, and slightly above the general level of the upper surface of the "gravel bed" (*c*), on which, as has been already stated, the "Bone-bed" (*d*) reposed. In passing in through this entrance, then, the water flowing over the limestone rock would fall in a sort of cascade on the detritus below, in which it would scoop out a basin-shaped cavity; and objects falling into and remaining in this hollow would be more likely to take an inclined or vertical than a horizontal position. Now, at this spot, but nowhere else, a basin (*g*) of this kind did exist in the "Gravel," and was filled with "Bone-earth;" and there, and there only, bones and stones, instead of lying horizontally, as they did everywhere else, were more frequently found sticking in the mud at right and smaller angles to the plane of deposit.

In an unusually narrow part of one of the galleries, aside from the line of direct water-flow, there existed, within the level of the "Bone-bed," seven or eight plates of stalagmite, from half an inch to two inches in thickness, alternating with as many layers of "Bone-earth" of about the same dimensions; the whole forming a vertical series, and extending horizontally from wall to wall across the gallery. The introduction of detritus, therefore, must have been an intermittent process. Though the direction of its flow was constant, the volume of the stream must have been variable, and sometimes so insignificant as to leave parts of the galleries comparatively dry. Though water, super-saturated with carbonate of lime, might be constantly dropping from the roof, it was during a dry period only that a cake of stalagmite could be formed on the deposit below. The return of flowing water would recommence the introduction and deposition of "Bone-earth," and suspend the precipitation of carbonate of lime, since the latter substance, by dropping into a flowing stream, would be carried elsewhere, probably out of the cavern. Each of these plates of stalagmite was made up of very thin laminæ, and thus showed its formation to have been slow and intermittent. Moreover, it was soil-stained throughout its structure, as if its formation had taken place very slightly

above and adjacent to a small, sluggish, somewhat muddy stream, which, experiencing slight fluctuations of level, was sometimes enabled to stain with earthy matter the films of chemical origin. It may not be out of place to remark here, that the "*floor*" of stalagmite was rarely stained in this way.

Here, then, we appear to have ascertained, somewhat in detail, the agency to which, in this instance, the cave accumulation was due. It was not carried in by an unrepeated and great rush of water, but by a small engulphed river, which entered at more than one entrance, escaped through a shaft within the cave; and was so liable to fluctuations in its volume as sometimes to fill the galleries, when it carried in stones, mud, bones of animals, and human tools fashioned in flint; whilst at others it allowed a part of the deposit to be sufficiently dry for the formation of a cake of stalagmite on it.

It must be unnecessary to remark that engulphed streams, of the kind here supposed, are by no means rare; nor is the case without something like an existing parallel in the caves of this county. One of the most interesting of the numerous caverns at Buckfastleigh was discovered about twenty years ago, and is situated very near the church. The entrance is somewhat difficult, and the pilotage intricate and not without danger. Huge masses of fallen limestone are very numerous, and stalactites of grotesque forms depend from various parts of the roof. The whole effect struck me as an embodiment of desolation in a very fantastic costume. When about halfway from the entrance to the farthest point reached, I heard the silvery voice of running water, and, guided by the sound, soon found a small stream, a part of whose course lay through the cavern. My visit was made during a very dry season, so that it is not improbable that the stream may at times assume larger dimensions.

There is a tradition that a considerable stream crosses a cavern in the parish of West Ogwell, near Newton Abbott.

Those who have visited Cheddar Cliffs, in Somersetshire, will remember that a large body of water issues from the base of the cliff on the right of the road ascending that remarkable defile. This stream is known to commence its subterranean journey about two miles off, where it enters a "swallet." It can scarcely be believed that it fails to introduce specimens of the zoology, botany, and mineralogy of the district it drains, and to deposit them, with evidences of the state of human art also, in some of the nooks and recesses

of what, through a small change of drainage, may hereafter become an accessible cavern.

The foregoing may be taken as examples of a second mode by which caverns received their accumulations.

Introduction of Accumulations by the Sea.—Amongst the numerous caves near the sea-level on the south-eastern coast of Devon, there is one between Berry Head and Mudstone, near Brixham, into which the sea enters only at spring tide high water, or during very heavy gales. It is accessible from the sea only, being situated at the apex of a small rift between lofty, vertical, rocky cliffs, and which at its entrance, where it is widest, is not more than about twenty feet across. Except at a very high state of the tide, a small, steep, terraced shingle beach lies between the mouth of the cavern and the sea. So far as is known, the cave is simply a gallery about eighty feet long, four feet wide, and commonly not more than three feet high, though sometimes lofty enough for a man to stand erect; that is to say, such is its height above the deposit it contains. A considerable drip of water, apparently free from earthy matter, enters through the enormous thickness of limestone constituting the roof. When, a few years ago, I attempted to explore it, the floor consisted of fine sea-sand, more or less covered with sea-weed, which had recently been washed in and was most abundant at the inner end. About forty feet from the entrance a few disjoined bones of a young terrestrial mammal lay on the sand. The sea had also carried in a portion of a tin kettle, and a fragment or two of a coarse basket, such as are used on board colliers.

Here, then, is a cavern which the sea is industriously filling, and into which it is carrying relics of man's handiwork and of his brute contemporaries; but, so far as I could discover, not any remains of marine organisms, with the exception of the sea weed. This may be regarded as an illustration of a third mode in which caves may receive their accumulations.

Introduction of Accumulations by occasional Land Floods.—The exploration of the cavern recently discovered in Happaway Hill, Torquay, is not yet sufficiently advanced to justify more than a first rough guess on the subject. So far as I can interpret the few facts which have been disclosed, the cavern appears to have been mainly filled, not by matter washed or falling in through a vertical opening, not by the symmetrical action of an engulphed stream, not by the agency of the sea, but by the fitful and capricious action of occasional land floods entering a sensibly horizontal opening. An unusually great rain fall, or an obstructed water course, appears

at various times to have caused a rush of water to enter a small cavern which was ordinarily left dry, and to mingle confusedly a heterogeneous mass of materials—huge blocks of limestone, rolled stones of various sizes, fine sand, clayey loam, bones of various animals including man, flint flakes and chippings, bits of charcoal, calcined stones, and roasted bones and shells. There can be no doubt that man had fixed his residence somewhere within or very near this cave, and it is certain that the materials were not all introduced at one time or by one effort. But farther remark on the cavern at present would be premature and ill-advised. It appears, however, that we may have here an example of a fourth mode in which caverns received their accumulations.

Kent's Hole, Torquay.—The famous Kent's Hole, near Torquay, temptingly suggests that the sea may have had something to do with the introduction of its materials. It possesses two entrances, each in the same natural cliff, and around one of them there are many well-marked lithodomous perforations. Moreover, on various parts of the interior, there are unmistakeable marks of the long-continued action of running water. But, in addition to the fact that it would at least be difficult to establish a connection between the interior and the exterior marks of aqueous action, these are indications of the agency by which the cavern was *formed*, whilst the present inquiry is, "How was it *filled?*" the answer to which must be sought in the deposits rather than on the walls between which they are lodged. So far as I am aware, the necessary attention has never been given to the arrangement of the Kent's Hole materials to warrant the formation of an opinion.

Fig. I.

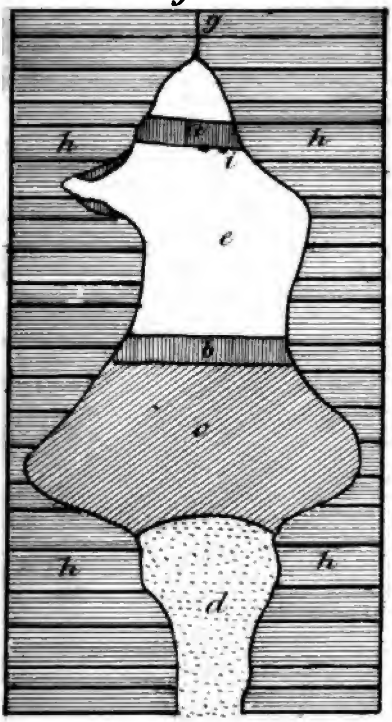


Fig. III.

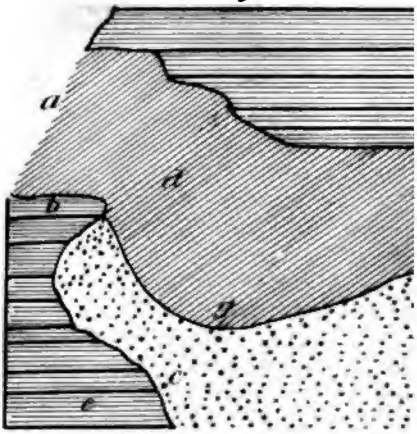


Fig. II.

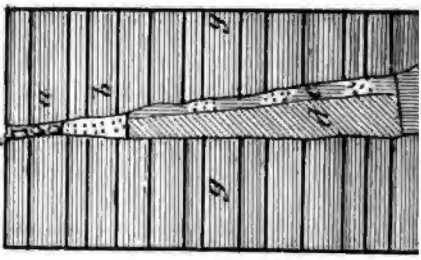
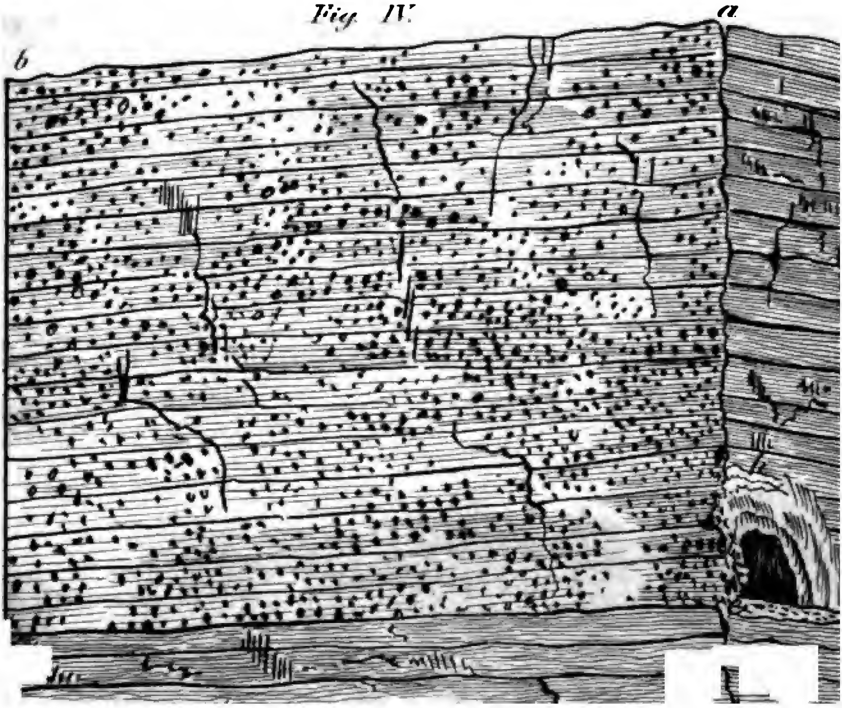


Fig. IV.



EXPLANATION OF THE FIGURES.

Fig. I. A vertical cross-section of the principal gallery of the Windmill Hill Cavern, Brixham, on the scale of $\frac{1}{48}$ linear, or quarter of an inch to a foot. (See page 31.)

a. A portion of an old stalagmite floor, sometimes called "The ceiling."

b. The stalagmite floor of the cavern when found in 1858.

c. The cave-breccia, consisting of loam, angular and rounded stones, bones of extinct and recent animals, flint implements, &c. This was sometimes called "The bone-bed."

d. "Gravel," having scarcely any traces of organic existence.

e. Space above the deposits entirely unoccupied when the cavern was found.

g. A close-fitting roof joint in the limestone rock.

h. Devonian limestone in which the cave is situated.

i. Fragments of stalagmite attached to the nether surface of "The ceiling."

Fig. II. A vertical cross-section of the cavern or fissure discovered at Oreston, near Plymouth, in 1858. Drawn on the scale of $\frac{1}{300}$, or one inch to twenty-five feet. (See page 33.)

a. The roof of limestone breccia.

b. "Gravel" of the workmen.

c. "Callis" of the workmen, containing bones.

d. Angular limestone, sand, and clay, with bones.

e. Tough dark clay, without bones.

g. Devonian limestone in which the cavern occurs.

Fig. III. A vertical longitudinal section of the western end of one of the galleries of the Windmill Hill Cavern, Brixham, on the scale of $\frac{1}{100}$ inch to a foot. (See page 37.)

a. One of the principal horizontal external entrances of the cavern.

b. The limestone base of the entrance or opening.

c. The "Gravel-bed."

d. The "Bone-bed."

e. Devonian limestone in which the cavern is situated.

g. The basin-shaped cavity in the "Gravel-bed."

Fig. IV. View of a portion of Wall's Hill Quarry, near Bishopstowe, Torquay. Drawn on the scale of $\frac{1}{100}$ inch to a foot. (See page 35.)

a, b, d, e, and *a, c, i, e,* are two sensibly-vertical joint-surfaces, having north-and-south and east-and-west directions respectively. The former surface was almost completely covered with angular and rounded *débris*.

h, e, g, is a small cavern about ten feet in length and height, at the bottom of which was a bed (*e, g*) two feet thick, composed of earth, sand, and stones, and in unbroken connection with similar detritus on the north-and-south joint surface.

THE

DENUDATION OF ROCKS IN DEVONSHIRE.

BY W. PENGELLY, F.R.S., F.G.S., ETC.

"*Denudation*"—strictly, the laying bare of new surfaces by the removal of superincumbent matter—is frequently applied by geologists to the processes, whether of disintegration or of decomposition, by which rock masses are destroyed and removed. In the present communication, the term will be employed in this latter sense.

The surface of Devonshire measures about 2585 square miles, and, with the exception of not more than one-tenth of this—occupied by granitic and trappean rocks,—consists of strata of various kinds and ages, from the crystalline schists extending from the Bolt Tail to the Start Point, to the modern beaches and alluvial plains which fringe its coasts and bound its rivers.

Derivative Character of Stratified Rocks.—When it is remembered that every rocky stratum was formed of the *débris* of more ancient rocks, it will be seen that the entire bulk of the stratified formations must have previously existed in an unstratified form. Whatever may be the volume of the derivative series, an equal volume of what may for the present purpose be called primitive rock, must necessarily have been destroyed. The magnitude of the structure is certainly limited by the amount of stone which has been quarried for it. Every square foot, then, of the large area just mentioned, testifies to the operation of denudation. Indeed, it will be shewn hereafter, that the granitic region itself is no exception to this general rule.

Many of our strata, too, will be found to be of secondary derivation, or even still further removed from the parent rocks. In many cases, beds built up of the *débris* of igneous rock, have themselves undergone denudation, and the detritus thus supplied, having been re-constructed into strata, has been once more torn down, to pass again and again through similar mutations. Thus the modern shingle beaches, ex-

tending from Torbay to the Exe, mainly consist of materials derived from the red conglomerate cliffs at the foot of which they lie; whilst the conglomerates themselves are principally formed of detritus supplied by the earlier waste of the Devonian and Carboniferous strata of the county; which, again, are clearly of derivative origin, and, in some instances, certainly not of immediate or primary derivation, since they too contain numerous fragments of earlier *beds*. In like manner, the sea beach extending, in unbroken continuity, from west of Sidmouth to the eastern verge of the county, is almost entirely made up of flints which were clearly derived from an enormous chalk formation, represented at present only by a few small outliers. The history of the chalk, too, though in a somewhat different way, is a chronicle of the waste of pre-existent rocks.

In the Sidmouth beach, however, there are certain pebbles in addition to the flints: these tell a still more emphatic tale, to which attention will be called hereafter.

The *volume* of material, then, which has passed through the processes of denudation and sedimentation, fails to represent the amount of *work* performed, or of *time* expended on it; this fact, however, by no means affects the truth of the proposition, "That all strata are the offspring of unstratified rocks." Immediately or mediately they must be so.

Rocks of Organic Origin.—The mention of chalk, in a former paragraph, reminds me that amongst our stratified rocks there are some of *organic* origin; namely, the lignites of Bovey Tracey, the culms of north and central Devon, and the limestones,—including, under that general appellation, the chalk already mentioned. The two first are so unimportant in volume as to require no more than a passing recognition; but the limestones claim further attention. Those—and they are by far the most important in the county—which occur in association with the Devonian slates and sandstones, are certainly due to animal agency. Many of them are fine examples of ancient coral reefs, whilst others are composed of comminuted animal exuviæ—sponges, corals, crinoidea, and shells. The animal origin of certain beds, however, is by no means so obvious; nevertheless, chemistry assigns to them, also, an organic source. Bischof informs us that the quantity of free carbonic acid in the sea is, at present, five times as much as is required to keep in a fluid state the quantity of carbonate of lime found in it; so that it is impossible that solid carbonate of lime can be formed as a precipitate *in the sea*. In other words, under existing conditions the formation

of marine limestone must be due to marine organisms, which abstract from the ocean the carbonate of lime dissolved in it. Those, however, who, before admitting this conclusion, require proof that the carbonate of lime never, in past ages, exceeded the solvent powers of the free carbonic acid of the ocean, must content themselves with the belief that some marine limestones may be of direct chemical origin, and this will not affect the real question at issue, which, after all, is not, "By what agency does the ocean part with its carbonate of lime?" but, rather, "How did it acquire this substance?" Doubtless the reply is, "By the solution, through the agency of thermal and acidulated waters, of rocks or rock detritus which contained it;" in other words, "by the destruction of earlier rocks."

But to return from this digression. Since Mr. Lonsdale's experiments nearly thirty years ago, it has been impossible to doubt the animal origin of ordinary chalk.

Our marine limestones, then, whether friable, as the chalk at Beer Head, or semi-crystalline, as in the district south of Dartmoor, must be regarded as structures reared, directly or indirectly, by humble tenants of the deep, and are thus wonderfully calculated to enhance our notions of geological time. According to M. Regnault (Chim. II. 193), the carbonate of lime at present held in solution in the ocean does not exceed three parts in 100,000; and this cannot be extracted more rapidly, on the whole, than it is supplied by the waste of the rocks which contain it. Assuming this to have been the condition of the old Devonian sea, how slowly must the forests of crinoidea, the beds of shells, and the coral reefs, have grown! and when completed, the whole, in many cases, had to be broken up, and much of it reduced to calcareous mud, preparatory to its being built into beds of rock, in which were inhumed the comparatively few organic forms which had been so fortunate as to escape the destruction which overtook myriads of their fellows. In order to an apprehension of the full significance of this, it is necessary to reflect on the fact that, with the exception of two per cent. only, all the species of animals, found as fossils in our limestones, came into existence *within* the Devonian period; that they extracted from the ocean the limited supply of building material which it contained, and built it into stony masses; that very much of the structures thus reared was torn down, triturated into almost impalpable mud, and then rebuilt into the limestone strata of which our hills consist; and that all this occurred far within the Devonian era.

Source of Lime in Nature.—It may be well to observe here, that, with some unimportant exceptions, all stratified rocks are divisible into three great classes,—silicious, argillaceous, and calcareous. The argillaceous or clay rocks are chiefly composed of silica and alumina; the former always, and sometimes very largely, preponderating. It is easily seen that the unstratified rocks, by their waste, could have supplied the materials which compose the two first kinds of strata; since silica and alumina, and especially the former, enter largely into their composition; but there is a difficulty respecting the source of the lime necessary for the numerous calcareous beds, since this earth is much less abundant in the unstratified series. It is possible, however, that much of this difficulty is due to the once-prevalent opinion, that the unstratified formations which formed the earliest crust of our globe, and, through disintegration and decomposition, furnished the materials for the primitive strata, belonged to the *granitic* series—a class of rocks eminently poor in calcareous matter. But if it be true, that the granitic rocks are of Plutonic origin,—that pressure was essential to the elaboration of their characteristic structure, they never could have been formed at the surface, and the primitive strata must have been built up of the waste of rocks of a different class. Now, there are, amongst the unstratified formations, rocks, such as Basalt and Dolerite, of which lime forms fully ten per cent., and Diallage rock, in which it is scarcely less abundant; all of which belong to the class known as the Augitic or Hornblendic group; hence, it seems not improbable that there was an early and large destruction of unstratified rocks of the Augitic series.

The Bovey Tracey Formation.—Though the Bovey lignite is of vegetable origin, the materials with which it is interstratified are the products of the mechanical and chemical destruction of earlier rocks. This deposit lies at the foot of Dartmoor, extends south-easterly for upwards of nine miles, varies in breadth from four miles to less than as many furlongs, and is known to be, in many places, at least 300 feet deep. Of this mass, the beds of vegetable matter, where most fully developed, barely make up 45 feet; the rest is sand and clay undoubtedly derived from the Dartmoor granite. In confirmation of this view of their origin, it may be stated that the sands are quartzose and the clays feldspathic; that their distribution is strictly related to their specific gravities —thus the clay has travelled further than the sand, the finest and lightest of each further than the coarser and heavier,

and the beds have a tendency to thin out or become attenuated with increased distance from the granitic region. All these phenomena are closely akin to those of the St. Austell works, where china clay is artificially prepared from decayed granite.

The Crystalline Schists of the Start and Bolt.—The crystalline schists at the southern angle of Devonshire have already been mentioned. (See Fig. I.) They belong to the class of metamorphic rocks; that is to say, they were once ordinary non-crystalline strata, but have been divested of all marks of their aqueous mechanical origin, with the exception of their stratification, and transformed into crystalline masses. Now, amongst other things, enormous pressure was essential to this metamorphosis, and this implies the former existence of a great accumulation of overlying beds, which, subsequently to the change, must have been swept away, since the schists are now bare and exposed at the surface. These rocks, therefore, conduct us through the following eventful history:—1st. The denudation of ancient rocks in order to furnish materials for the formation of the schists. 2nd. After the deposition of the detritus thus obtained, a further denudation, followed by the deposition of the consequent *débris* in the form of the overlying beds, which produced or, more probably, resisted the pressure required for the metamorphosis of the inferior strata. 3rd. The re-denudation of the super-imposed formation after the alteration had been effected in the beds below.

The work of destruction was by no means stayed here, as the famous Bigbury-bay outlier of Triassic conglomerate is mainly composed of fragments of the transformed schists.

The Dartmoor Granites.—The granites of Dartmoor, to some extent, tell the same story. Their crystalline structure, like that of the schists, indicates that they, too, were nether-formed. Pressure, implying overlying masses, was essential to the development of the granitic characteristics; and, as in the case just discussed, the superincumbent beds necessarily denote two denudations.

But is it certain that the granites themselves do not contain a history of still more ancient denudations? The answer to this question hinges on that of the origin of granite. If prior to becoming that aggregate of crystallized minerals to which we give the name of granite, the materials composing it had never been in a solid condition, but had remained beneath the earth's crust, a slowly cooling portion of that fluid mass which some cosmogonist tells us was formerly the state of our entire planet, they have nothing further to reveal to us respecting denudation. But if a view now attracting atten-

tion, and, indeed, becoming more or less prevalent, should prove to be correct; that is to say, if it be true that granite is but the extreme form of the metamorphosis whose partial effects are seen in the crystalline schists, then the unstratified rocks of Dartmoor may have been simply beds which have been *destratified*, and were therefore formed of the detritus into which denudation had converted earlier rocks.

Denudational Pauses in the Process of Sedimentation.—In a Paper on the Chronological Value of the New Red Sandstone of Devonshire, which I had the pleasure of reading to the Association during its last meeting, it was shown that during the formation of the red rocks, there were pauses, in which not only was the work of sedimentation suspended, but large masses of the deposited matter denuded; and that pauses of the kind must have been of somewhat frequent occurrence.*

The phenomenon is by no means confined to the Triassic deposits. A fine example occurs in the Devonian limestone near Hope's Nose, Torbay, where the rocks resolve themselves into two unconformable series of beds (see Fig. II); the lower (1), including several interstratified beds of volcanic ash, are violently contorted, and support the upper undisturbed beds (2) which dip eastward at an angle of 2° only. It is obvious that the contortion of the first took place prior to the formation of the second. The bed *a*, *b*, of the contorted group is fractured at *a*, the vertex of the fold; that is, at the point of greatest flexure, and, therefore, of greatest tension: the contortions prove that the limestone was plastic enough to bend; and that it was brittle enough to break is as clearly shown by the fracture. On the right or east of *a*, there are three beds *c*, *d*, *e*, which come up to the approximately horizontal line *a*, *e*, where they are sharply cut off; they clearly belong to the lower series though they do not now pass over the vertex of the fold; on the west of *a*, however, there is a fragment *e*, of the bed *c*. There can be no doubt that the line *o*, *e*, or, more correctly, the surface it represents, was produced by denudation subsequently to the contortion of the first series, but prior to the formation of the second.

The section discloses the following history:—

1st. The formation of the lower series by the deposition of triturated organic exuviæ; the process being frequently intermitted, as is proved by the separability of the beds and the interstratification of volcanic ash.

2nd. By the operation of some approximately lateral force,

* See Report of Second Meeting of the Association, pp. 33, &c.

the beds were contorted, and were fractured at the point of greatest flexure.

3rd. The uppermost existing beds (*c*, *d*, *e*) of the series were exposed to the action of the waves, and thereby planed down to the approximately horizontal surface *o*, *e*.

4th. Subsequently to this denudation, the upper beds were deposited unconformably on the lower.

5th. Though these processes must have absorbed an enormous amount of time, they were all completed within one and the same division of the Devonian period, as is proved by the specific identity of the numerous fossils in the two series. It appears, moreover, that this constituted but a small fraction of the Devonian era, as the Torbay limestones underlie and overlie enormous deposits of slate, so that they are more modern than the slates below, but more ancient than those above them; yet the whole—slates, limestones, slates—fail to represent the entire Devonian system; neither the lowermost nor the uppermost beds of which occur south of Dartmoor.

It would be foreign to my present purpose to do more than to state, in passing, that this interesting section is replete with information respecting the Cleavage of rocks.

Devonshire Outliers.—Any correct geological map of Devonshire shows a considerable number of small, detached, and, in many cases, widely-separated patches of certain rock formations: they are termed *outliers*, and are regarded as the remnants and proofs of a formerly greater horizontal extension of the deposits to which they belong; in other words, they afford evidence that these deposits have, in this county, lost much by denudation. For example, there are outliers of the Devonshire Trias on the shores of Bideford Bay, Bigbury Bay, Slapton, Berry Head, and Hatherleigh. Some of them are very small, and not only far asunder, but, with the exception of the last only, are widely separated from the great mass of the formation. Indeed, the greater proximity of the Hatherleigh patch is simply due to the extension westward, by Crediton and North Tawton, of a long narrow strip, itself probably a remnant of a greater mass which once occupied that region, and, as such, is equally a proof of denudation.

In like manner there are outliers of Greensand on Haldon, Milbern Down, and other localities west of the Exe; whilst the continuous formation commences not only east of this river, but beyond the Otter also. One very diminutive fragment—not more than a few acres in area—exists "at Orleigh Court,

near Bideford, forty-three miles and a half from the Greensand of the Black Down Hills, and thirty-six miles from that of Great Haldon Hill, which is nearest to it."*

Now were these various outlying fragments connected by means of a series of lines, in each case a great extent of country would be inclosed, over, at least, a large portion of which the Triassic and Greensand formations respectively extended in some earlier period. Indeed, it is not improbable that the areas thus indicated fall below the truth. Denudation may have been so active as to leave, in some localities, no relic to attest its operation. For example, had the bit of Greensand at Orleigh Court been destroyed, no indication would have remained of a formation of this rock having formerly covered a very large portion of central Devon; had the sea entirely removed the red conglomerate cliff at Thurlestone, in Bigbury Bay, there would have been nothing to suggest the fact, that rocks of Triassic age had once spread over a large part of the extreme south of the county; or had the small ship load—for it really amounts to no more—of New Red Sandstone which remains *in situ* on the sea cliff behind Brixham been entirely destroyed, there would have been but little evidence that the Trias once extended over the limestone peninsula of Berry Head.

Small isolated patches of Chalk, too, occur capping the Greensand in certain localities east of Sidmouth, and tell a similar story. They account, also, for the myriads of flints which mainly compose the modern sea beaches east of Budleigh Salterton, and which, from their fossil contents, were undoubtedly of chalk derivation: the perishable chalk has disappeared, but the durable flints conclusively prove its former existence; their rounded forms, however, show that they have undergone much wear and tear, and have lost much of their original volume.

Greensand Areas Covered with Untravelled Chalk Flints.—Some of the Greensand hills, though destitute of chalk coverings, are not without indications of the former existence on them of beds of this kind of rock; indications, too, which tell a wonderful story of denudation, and of the time expended on it. Examples occur of hills of this kind being covered with thick accumulations of chalk flints, entirely unrounded, and still retaining all their original grotesque angularity, as well as their thin covering of calcareous matter. Their fossils prove that they were derived from a chalk deposit, the great thickness of which is indicated by their numbers

* Sir H. De la Beche's "Report," p. 236.

and volume. This great mass of chalk, then, has been destroyed; but the flints lie on the greensand, that is, they occupy the situation proper to a chalk formation, and it has been already stated that they possess untravelled forms; hence the chalk must have perished where the flints are found. The agent of destruction was not possessed of great *mechanical* power; it was capable of destroying and removing the chalk, but not of transporting the flints; it was not the ocean, but the atmosphere. Rain water charged with carbonic acid dissolved the chalk, which was then carried by a thousand rills to the rivulets, by them passed on to the larger streams, and so on, probably, to the ocean. The work was indescribably slow, but unceasingly carried on; the power of the operator was immense simply because it was a product one of whose factors was unstinted time. Nor is the work yet ended: the numerous small land-springs occurring in the cliffs between Sidmouth and Beer Head, bring down carbonate of lime from the chalk outliers, and deposit considerable masses of calc tufa, in many instances turning grass and leaves into stony matter by their "petrific touch."

Islets on the Devonshire Coasts.—What are the numerous islets which fringe our coasts, from the Mewstone at the entrance of Plymouth Sound, to the picturesque group in Ladrum Bay, near Sidmouth, but so many outlying relics of an ancient coast line? The land which connected them with the existing main has been destroyed by denudation, and the amount that has thus perished may be estimated by the amplitude of the interspaces. In some cases they differ lithologically from the coasts they guard; thus, along the northern side of Torbay a linear series of limestone islets extends parallel to a slate coast, tipped at each extremity with limestone: these fragments are the vestiges of cubic miles of calcareous rock. Their isolation testifies to a recent denudation, their stratified arrangement to an older one—a prerequisite of their formation, and the fossils with which they are crowded are equally emphatic respecting the organic agencies concerned in their erection. (Fig. III.)

Terraces of Denudation.—It frequently happens, however, that a wasting coast is manifested even where there are no such islets, which, after all, are but the results of irregular or unequal action or resistance; the destruction would have been greater, directly and indirectly, had they also perished. The strand left bare by the retreating tide is not unfrequently a rocky platform instead of a beach of sand or shingle,—a terrace of *denudation*, not of *deposition*. The waves first

sapped and removed the rock masses which once rose loftily from this terrace as a basis; and then ground down the inequalities só as to reduce to a sensibly plane surface the outcropping edges of highly inclined strata. The waves are frequently seen to break at low water upwards of a quarter of a mile sea-ward from our headlands—the points which retreat least rapidly; and to this extent, at least, has denudation operated since last the relative level of land and sea was changed in this part of England.

Terraces of this kind, representative of earlier periods, are by no means rare,—platforms which tell the twofold story of denudation and an intermittent upward movement of the land. To go no further than the Torbay district; such terraces are displayed in the limestone plateaux of Berry Head, Daddy's Plain, Anstey's Cove, and Babbacombe Downs, and, in short, wherever limestone reaches the requisite elevation.* These remarkably flat uplands are not planes of stratification; so far from it, indeed, the strata have in each case a very considerable dip, and their outcrops have been shorn down to one tolerably uniform level. We are taken back to a time—not very remote geologically—when the entire district was below the sea level; it may be safely said *just* below, for it is possible to determine within a very few feet how much lower than now it must have been. The sea which covered it must have been very shallow—perhaps it was even a tidal shoal; the grinding action to which it was subjected must have been that of the breaking waves, and its duration must have been immense. Should it be asked, "Why are not the slates and red sandstones, which attain an equal height, marked with a corresponding terrace?" it may be replied, "They doubtless were so formerly." Indeed, from being softer and more easily wrought, the phenomenon must have been more readily produced in them than in the hard semi-crystalline limestone; and, for the same reason, more readily effaced. Their friable and perishable nature has enabled atmospheric agencies to obliterate all traces of the ocean's work: the history, distinctly inscribed on three different tablets—sandstone, slate, and marble—has been preserved only in the last.

Raised Beaches of Devonshire.—Below the terrace just described—indeed, no more than about thirty feet above the sea—we have, as is well known, a series of Raised Beaches, which occur numerously on the shores of both the English and Bristol Channels. It is scarcely necessary to observe that they are not met with where the encroachments of

* See "Ancient Sea Margins," by R. Chambers (1848); page 245, &c.

the sea have been very rapid, as within the new red sandstone district. They usually occupy platforms or terraces in the hard rocks, whether of limestone or the more durable slates, as is well seen in the raised beach immediately east of Dartmouth harbour (see Fig. IV.); hence the period they represent divides itself into two: that—the earliest—in which the shelf was chiselled out, and afterwards that in which the beach was deposited. In the first, denudation on the spot cut the platform; in the second, it elsewhere quarried the materials to form the beach.

Slabs of Rock Cemented to Cliff-Faces.—A somewhat unusual proof of the waste of the coast is occasionally seen in the limestone cliffs south of Berry Head, which will be more readily understood by means of Fig. V. Let *a, c,* be a sea cliff, the termination of the limestone headland *a, b.* Let *d, e,* be an open fissure, having irregular walls, and traversing the rock in a sensibly vertical direction. (Such fissures are numerous in the Torbay district.) Let *m, o,* be slabs of stone which, having fallen in, are caught and retained by the inequalities of the walls. Now if water, super-saturated with carbonate of lime, trickle down the face of the wall *d, e,* it will cement the slabs to it, after which the mass *a, c,* will be no longer needed, and its removal will not affect the slabs. They, however, will not fail to make known its former existence, though no vestige of it may remain; simply because it will be evident that they must have had a support of the kind prior to their cementation. Now, near Berry Head slabs of this sort are to be seen clinging to the face of the cliff upwards of one hundred feet above the sea. There can be no doubt that they prove that denudation has removed a mass of rock which once existed beyond them, and reached a height at least equal to theirs, and that the work of destruction extended downwards to the present sea bottom.

Budleigh Salterton Pebbles.—It has been already stated that the beach extending from Sidmouth to the eastern extremity of the county is almost entirely made up of flint pebbles. Occasionally there are found amongst them a few, well-worn, polished, fossiliferous, quartzite stones of ellipsoidal form, whose history—very recently unravelled—is of great interest, especially in connection with the present subject. These stones constitute the principal material of the beach at Budleigh Salterton, particularly on the west of the village. East of Otterton Head they are by no means so abundant, and they become less and less plentiful further and further eastward; nevertheless, they are easily detected at

Sidmouth, Branscombe, Seaton, and Charton and Pinney bays. The foregoing facts are sufficient to show that their source is in the Budleigh Salterton district, whence they have travelled eastward a distance of fully eighteen miles, doubling Otterton and Beer Heads, and other less important points of land. They are largely exported from Budleigh Salterton for road-making, for which they are well adapted; the supply, however, is well kept up, so that there must be a large amount of denudation going on at present.

The source whence they are derived is not far to seek. There exists, in the Triassic cliffs immediately west of Budleigh Salterton, a bed, about one hundred feet thick, almost entirely made up of pebbles from the size of hazel-nuts to that of a man's head, and in all respects identical with those just mentioned. The bed dips at a rather considerable angle in a north-easterly direction, so that it rises from the beach diagonally in the cliff section, and at its outcrop, considerably west of the village, forms the lofty West Hill, or West Down,—the highest ground on this part of the coast. It extends several miles inland, and constitutes a prominent feature in the landscape, so that its volume must be very considerable.

The denudation of this bed furnishes the pebble beach of Budleigh Salterton; but this waste is by no means a novelty in the local geology. Gravels, of which I shall presently have to speak more at large, spread far and wide over this part of Devonshire: they must have accumulated under geographical conditions very unlike those which now obtain, and they belong to a period of considerable antiquity, but which it would be very difficult to determine at present, further than that it is certainly Quaternary or late Tertiary. In the district now under notice, these gravels are rich in pebbles derived from the bed just mentioned, so that it must have lost very much by denudation before the commencement of the modern beaches. Great as is its existing volume, it is but a fraction of the original accumulation.

But the pebble bed itself is a result of an earlier denudation, being a stratum of fragments which have had much wear and tear. It is worthy of remark, that the pebbles which have performed the modern journey from Budleigh Salterton to Pinney Bay, and those which remain in the bed in the former locality, are identical in form. Re-denudation and a transportation by waves over eighteen miles of rough coast, have served only to reduce their dimensions, not to change their shapes; their earlier journey in the Triassic sea

had given them the only form of which their structure is capable,—a polished oblate spheroid.

But whence came these pebbles? Where were the parent quartzites which, during Triassic times, sent these fragments to the area now known as south-eastern Devonshire? It has already been stated that the pebbles contain fossils; these have been largely collected by Mr. Vicary, in the well-founded hope that they might furnish an answer to the question just proposed. Amongst these remains there are several well-preserved trilobites, which at once prove that the rocks in which they were inhumed were not more modern than the Mountain Limestone,—the most recent formation in which trilobites occur. This, however, is anything but definite; but beyond it nothing was known further than that the fossils do not belong to the Devonian series, until Mr. Vicary was so fortunate as to secure the assistance of Mr. Salter, the eminent palæontologist, who, jointly with their discoverer, read a paper on the fossils before the Geological Society of London, in December last; from which it appears that they are Lower Silurian forms, well known as occurring in quartzite beds in Caen, in Normandy, but having no exact representatives in Britain. Lithologically and palæontologically, the pebbles are of French extraction.

In order to the acceptance of this statement, it is necessary to suppose, that during the Triassic era an unobstructed sea existed between the areas now known as Normandy and Devonshire; but, though unobstructed, it must have been shallow, since the waves were capable of transporting the pebbles: it could not have had a depth at all approaching the forty fathoms of the existing channel. It is necessary, moreover, to suppose that the most elevated point at which the pebble bed now exists—such as Woodbury Common, which is from 85 to 90 fathoms above the level of the mean tide—was then the sea-bottom, or not far above it: in other words, the English Channel did not then exist, but has been formed by an excavation or local subsidence since Triassic times.

Mr. Salter's decision takes us back to a period remotely ancient beyond our power of conception, but not to the commencement of the history disclosed by the pebbles. The quartzites which furnish them, being fossiliferous, were necessarily stratified rocks, and therefore formed of the products of denudation. Some rock of higher antiquity, rich in quartz, had been broken into fragments and triturated into fine sand, and in this, while being deposited, were buried the

remains of contemporary marine animals. Nor even yet have we exhausted the evidence of denudation. Quartzite is a metamorphosed rock; a deposit which has undergone some degree of transformation though a comparatively slight one. It must have been subject to pressure implying superimposed deposits, which were also the monuments of denudation; and before the altered beds below could send the first fragment to Budleigh Salterton, the overlying strata must have been stripped off by re-denudation.

Briefly to recapitulate, in the order of history, the extracts just made from this ancient record, we have—

1st. The denudation, during the Lower Silurian era, of pre-Silurian rocks which contained a large amount of quartz, the minute trituration and the deposition of the arenaceous detritus, and the inhumation in it of the remains of contemporary marine organisms.

2nd. The production, by denudation, of a large amount of *débris* which was deposited *on* the arenaceous beds previously formed.

3rd. The metamorphosis of the inferior beds by which they were converted from sandstones to quartzites, without obliterating the fossils.

4th. The denudation of the overlying strata so as to lay bare the transformed rocks.

5th. The denudation of the quartzites during the Triassic era, and the transportation, across a shallow sea, of myriads of the fragments to the area now known as south-eastern Devonshire, where they arrived in the form of polished ellipsoids, and were built into what is now termed "the Budleigh Salterton pebble bed."

6th. The denudation of the pebble bed, during one of the Supra-cretaceous periods, by which much of the material of the ancient gravels, covering a large part of south-eastern Devonshire, was produced.

7th. The continued denudation of the pebble bed, so as to supply pebbles sufficient to form the very extensive modern beach at Budleigh Salterton, to assist in the construction of beaches for nearly twenty miles along the coast eastward, and to carry on a large exportation for road-making.

Age of the Metamorphic Series of the Bolt and Start.—Whilst I have no doubt that the pebbles may have had a Norman derivation, and though there is certainly no locality whence they could more easily have come, I am not quite satisfied that no fossils of precisely the same species occur in Britain. There are quartzites in the Dodman district, and

especially near Gorran Haven, in Cornwall, in which, in 1837, Mr. Peach found fossils, and which, in 1846, Sir R. I. Murchison, aided by these fossils, pronounced to be of Lower Silurian age.* This opinion was confirmed by Professor Sedgwick in 1851.† Nor did Sir Roderick fail to recognize the geological connection of the Dodman with the opposite coasts of France, as the following passages show:—"There is the strongest analogy between the slates and granites of Cornwall and those of Brittany and Normandy."‡ "The band of silicious grits and quartzites in the south of Cornwall, which I had termed Silurian in 1846, presents much of the character and aspect of the opposite rocks of Brittany, which the French geologists have mapped and described as Lower Silurian."§

It is possible, therefore, that, instead of travelling from Normandy, the pebbles may have been derived from a portion of the same system which once existed between the Cornish and French coasts. This, however, is a matter of detail, and does not affect the general inferences which I have drawn. The subject, nevertheless, is one of interest to us, as it may be capable of giving some information on an unsolved problem in our local geology.

The Dodman and Lizard, in Cornwall, consist of metamorphic rocks; the former, as we have seen, fossiliferous quartzites, in which the transformation has been comparatively inconsiderable; the latter, talco-micaceous schists, in which the change is more strongly marked. The southern angle of Devonshire, as we have also seen, consists of mica-slate; and if a line be drawn from the Bolt to the Lizard, it passes very near the Eddystone rock, which is a gneissic variety of mica-schist, and, without doubt, a relic of a once extensive formation belonging to the metamorphic series. Now, the age of the crystalline beds of South Devon has never been determined. There has been a tendency to consider them the most ancient stratified rocks of the county, which may, indeed, prove to be the truth, but it was simply because it was orthodox to believe that all crystalline formations belonged to an earlier period than those of a non-crystalline character—an entirely exploded dogma. Professor Sedgwick, however, has speculated on the possibility of the Start and

* Trans. Royal Geological Society, Cornwall, vol. vi. page 317, &c.
† Quarterly Journal, Geological Society, vol. viii. page 1, &c.
‡ Trans. Geological Society of Cornwall, vol. vi. page 323.
§ "Siluria." Third Edition, page 160.

Bolt series being an altered portion of the Middle Devonian System.*

I cannot help thinking, that the Budleigh Salterton pebbles may help us somewhat towards a solution of this problem. May not the crystalline rocks of the south of Devon and Cornwall, including the Eddystone, be parts of one great system?—rocks of the same age which have undergone metamorphism, the schists being the results of the more, and the quartzites of the less, intense action of the transforming agents? The Budleigh Salterton pebbles show that such change as had been wrought in the quartzites was achieved prior to the Triassic age; and the outlier of red conglomerate in Bigbury Bay (see Fig. I.) proves the same thing for the schists of South Devon.

The Valleys and Gravels of South-Eastern Devonshire.—The most casual observer cannot fail to be struck with the evidence of denudation presented by the valleys in the south-east of Devonshire, as seen in the transverse section on the coast, especially beyond the Exe. The hills bounding the valley of the Sid, for example (see Fig. VI.), have gentle slopes, and reach considerable elevations; the western being the Peake Hill, and the eastern Salcombe Hill. The geological structure of either is exactly repeated in the other; each is divided into two stories, the lower being the chocolate-coloured marls of the Trias, and the upper the bright yellow beds of the Greensand. The colours are so strongly contrasted, and the line of demarcation so well defined, that the attention of every one is arrested: no one hesitates to accept the proposition, that the valley was cut since the Cretaceous era, and that the entire space from hill top to hill top was once filled with marl and greensand. The thing is so very patent that no argument is needed even to show the height which was reached by the excavated marl; it must have been, as in the hills, about two-thirds of the entire elevation. Here, then, is a clear and simple example of denudation, and the tale is repeated in all the numerous valleys along the coast; but to stop here is to fall very far short of the whole truth. Whence the marl and greensand that once occupied the valley? They were amongst the most decided examples of mechanically formed rocks; the materials of which they were built up were the products of denudation carried on elsewhere. The excavation of the valleys is but the *second* denudation recorded in their history. Nor must we stop here. From the bottoms of the valleys, up the

* Quarterly Journal, Geological Society, vol. viii. page 1, &c.

slopes to the summits of the hills, covering the uplands between them, and extending for miles inland, there are thick accumulations of gravel, previously mentioned, made up of the *débris* of the rocks of the district—flint, chert, greensand, marl, and Budleigh Salterton pebbles. The valleys are necessarily older than the gravels thus lodging in and over them; since their first excavation they have been re-filled and re-excavated. There are not simply one or two, but four great denudations disclosed by an analysis of the phenomena of the surface configuration of south-eastern Devonshire: 1st, the denudation of pre-Triassic, and subsequently of pre-Cretaceous rocks, to supply detritus for the formation of the beds which originally filled the valley spaces; 2nd, the post-Cretaceous denudation of these beds in order to the formation of the valleys; 3rd, the denudation which furnished the material for the obliteration of the valleys, by filling them with gravel from base to hill-top; and, 4th, the denudation of the gravel by which the valleys were partially re-opened. A remnant of the gravel remains to line the slopes and to preserve a record of the operations. Had the destruction been complete, there would have been no evidence that it had ever occurred.

Perhaps nothing connected with these changes is more remarkable, than the fact that there has been no alteration in the lines of drainage; wherever there is a river or valley now, there one existed before the deposition of the gravel, and *vice versâ;* the excavating agents took precisely the same courses both before and after the gravel era.

Though there are great difficulties connected with the subject, I cannot help thinking that the gravel was deposited during a period of slow and gradual subsidence of the entire district, and re-excavated during as gradual an upheaval; and that, during the maximum depression the sea prevailed over our hills. Unfortunately, there appear to be no fossils to decide this point; but the following fact seems to show that the gravels are of marine origin. During a recent examination, with Mr. Vicary, of those which occur on Woodbury Common, I was so fortunate as to find in them a nodule of greensand crowded with lithodomous perforations; it is possible, however, that the perforations were made before the fragment of greensand was broken off the parent rock: nevertheless, in the absence of evidence to the contrary, the facts of the case are more consonant with the hypothesis of a marine, than of a fresh water origin of the gravels.

Fig. II.

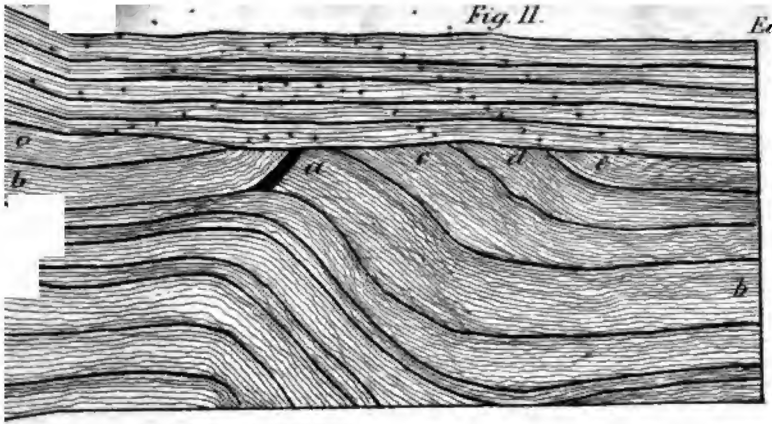


Fig. IV.

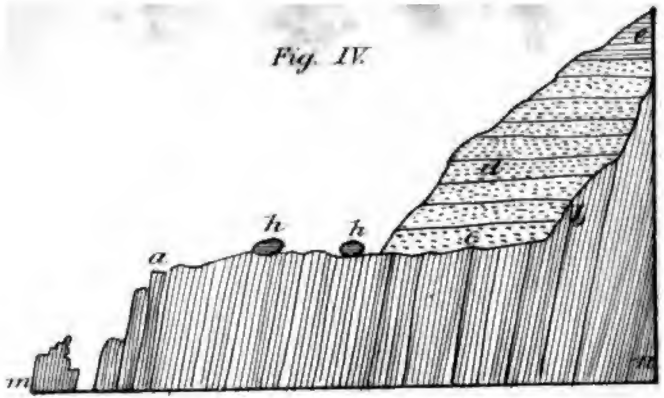


Fig. III.

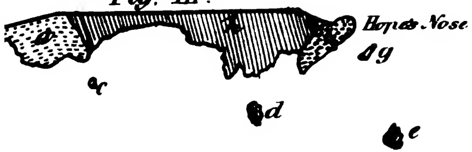


Fig. I.

Fig. V.

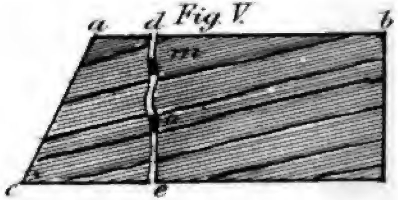
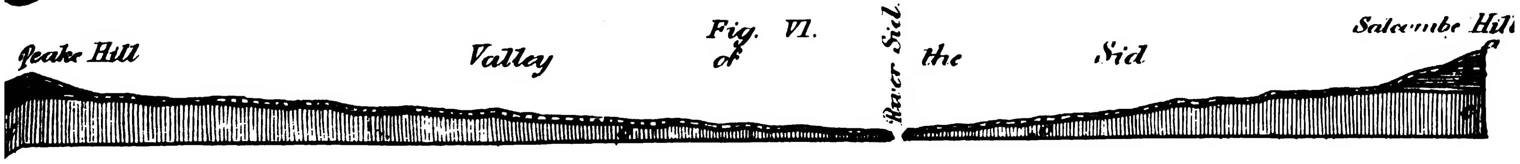


Fig. VI.



EXPLANATION OF FIGURES.

Fig. I. Map of the coast of the southern angle of Devonshire, on the scale of one inch to ten miles. (Page 46.)

a. Crystalline schists.

b. Devonian slate.

c. Thurlestone outlier and rock of triassic conglomerate.

d. Slapton triassic outlier.

Fig. II. Cliff section near Hope's Nose, Torbay, on the scale of one inch to sixteen and a half feet. (Page 47.)

1. Contorted Devonian limestone, with interstratified volcanic ash.

2. Devonian limestone beds, dipping eastward at about 2°.

a, *b*. A contorted bed, fractured at *a*, the vertex of the curve.

c, *d*, *e*. Truncated contorted beds, which, prior to denudation, were continued over the vertex, as shown by the dotted lines.

o. A portion of the bed *c*.

Fig. III. Map of the northern shore of Torbay, on the scale of one inch to a mile. (Page 50.)

a, *b*, *c*, *d*, *e*, *g*. Devonian limestone; *h*, Devonian slate.

c. The Shag Rock; *d*, the Thatcher; *e*, the Orestone; and *g*, the Lead Stone, or Flat Rock.

Fig. IV. Raised beach and terrace of denudation immediately north of the entrance to Dartmouth harbour, on the scale of one inch to forty feet. (Page 52.)

a, *b*. Platform or terrace of denudation, in Devonian slate, about twenty-eight feet above mean tide.

c, *d*. Raised beach; *c*, well rounded gravel, consisting of quartz, flint, and grit; *d*, fine sand, distinctly stratified.

e. Angular matter from the hill above the beach.

h. Boulders of grit.

m, *n*. Sea level.

Fig. V. Is intended to explain the phenomena of slabs of stone cemented to the face of a sea cliff. (Page 52.)

Fig. VI. Transverse section across the valley of the Sid, from Peake to Salcombe Hills, on the scale of one inch to 1,170 feet. (Pages 58 and 59.)

a. Supra-cretaceous gravel.

b. Greensand.

c. Trias.

ON THE FISHERIES OF DEVONSHIRE.

BY DR. SCOTT.

An old English writer—Speede—says of Britain: "In a word, Brittaine is so rich in commodities, so beautiful in situation, and so resplendent in all glory, that if the Omnipotent, as one hath said, had vouchsafed to fashion the world round like a ring, as He did like a globe, it might have been most worthily the only gem therein! Whose valleys are like Eden, whose hills are as Lebanon, whose springs are as Pisgah, whose views are as Jordan, whose walls are the ocean, and whose dependance is the Lord Jehovah." This description, so proudly given of England, may fitly be applied to Devonshire, the fairest spot in its area.

Devonshire has an extent of 1,657,180 acres, and a population of about 600,000 souls. Its physical features are diversified more than those of any other county, its climate is salubrious, its scenery varied and picturesque,—now giving us the rich umbrageous valley, and now the rugged torr and the wild moorland; and, since the introduction of railway communication, it is brought within a few hours' ride of the metropolis of the island.

The wealth of Devonshire is extensive, and arises from various sources. We have abundant pastures and fertile cornfields, well-timbered forests of oak and elm, mines producing fabulous dividends, and orchards prolific of fruit of the richest kind, yielding a produce annually of little less than £400,000 in cider. Though this enumeration of wealth would seem an ample dowry for any county, there is still another source of riches which, if properly cared for and developed, would equal any one of those I have named, I mean that of the *Fisheries of Devon.*

Looking at the map of Devonshire, we see that coast forms two of its four sides, the north and the south, the former being 72 miles and the latter 140 miles in extent. The rivers of Devon are also numerous, and, without counting the smaller ones, may be given as follow: The Tamar, the Tavy, the Plym, the Erme, the Avon, the Dart, the Teign, the Exe,

the Axe, the Taw, and the Torridge, forming an aggregate length of nearly 400 miles. No county in England can record more extensive water privileges than these, offering as they do, the best facilities both for salt and fresh water fish, which, with care and development, are capable of being made important sources of national wealth.

In the Paper I have ventured to bring under the notice of the Association to-day, it is my desire to draw attention to the importance of this source of wealth, to urge measures being taken for its development, and to offer a few suggestions for the best means of doing so. I shall arrange my remarks under the following heads:—

1. That a good supply of fish is of considerable national importance.

2. That Devonshire, from its extensive coast and numerous rivers, possesses great opportunities for fish production.

3. That fish in Devonshire has become scarce in late years, and is yearly becoming scarcer.

4. Some suggestions for improving the Fisheries in Devonshire.

First, then, of all classes of animals there is not one which affords so great a number of species useful for the food of man as this; and its character is such, that it is alike enjoyed by the lowest savage and the most refined epicure. From the earliest ages fishing has been carried on, either to supply the immediate wants of the fishers, or to form a commercial product of value. The rude savage finds one of the most reliable sources for administering to his daily wants in the streams and lakes of his country; and, as man advances in civilization, fisheries administer much to the extended requirements of his prandial desires. The Romans had their oysters from Britain; and we read that an Egyptian king gave the produce of one of his lakes to his queen, in order to purchase her perfumery and other elegancies for her toilet. Both Greeks and Romans paid the greatest attention to their fisheries, and no modern epicure is more choice in his piscatorial dishes than were the gourmands of old. Pliney says, "that cooks cost more than triumphs, and fish more than cooks." Lucullus, that noted epicurean dandy, once sold his stock of fish for £35,000. Some of the Romans had their arrangements for cooking their fish so perfect, that they ran them at once out of icy-cold water into boiling cauldrons, so that their flavour might not be injured by handling. The importance in which the subject was held amongst the ancients may be judged from the legal regulations made respecting it. A statesman,

said to have been as wise as Solon, ordered all dealers in fish to place upon a tablet above their stalls their prices, and forbade them to sit down till they had sold all their stock, so that they might be induced to sell on easier terms. Another law was enacted which made it imprisonment for a dealer to ask more than he meant to take. These laws would lead us to suppose that some of the vices of the fish-dealers of our own times trace back their origin to a very early period. In modern times the Dutch have been a people who have paid the most attention to their fisheries, and they have reaped great advantages from them, though maritime states generally have fostered fishing as a source of national wealth not to be overlooked. In the northern parts of Europe fish not only nourishes the inhabitants, but, mixed with sea-weed, it is given to cattle; and we are told that cows so fed not only yield milk abundantly, but that it is of good quality. The practice has also been long followed in some parts of India; and in ancient times it is related, that the Lydian and Macedonian sheep grew fat with this kind of nutriment.

Probably, the reason for the Dutch having done so much with their fisheries is, that they have but few inland resources, compared with other countries, and hence have given more attention to their seas, which have been made to add so considerably to their national prosperity. In 1668 the subjects of the States General were 2,450,000, and out of these there were not less than 450,000 maintained by fishing. They have long exported, and still export, fish to other markets, and now send large quantities annually to London.

A good deal has been written recently on the cultivation of our fisheries, and more active measures are being taken for their development. But as early as Queen Anne (1710) an Act was passed for the preservation of the fisheries of the river Thames, and power was given to the Fishmongers' Company, under the control of the Court of the Lord Mayor and Aldermen, to form regulations for their management. Other Acts were framed afterwards for the same purpose, but from some cause or other these, as well as more recent ones having a more general application, have all more or less failed. The causes of this failure it is difficult to point out, but they may probably lie either in a want of exactness in the details of the Acts themselves, or in a feeling of the people that seas and rivers are public property, and so any Acts restricting the public from using them as it likes are oppressive, and not to be obeyed. Our modern legislators appear now, however, to be taking more earnest measures to

amend our fishing laws; so let us hope that improvement is not far off; and my Paper of to-day has for one of its objects that of impressing upon my audience the importance of securing for our fisheries a good legislation, and impressing them with the necessity of using their best efforts to secure this object, so that our Devonshire Fisheries may be placed in such a position as will make them not only an important source of wealth to our county, but of considerable national value; for any country which is obliged to spend twenty-five millions sterling in foreign markets for the purchase of its bread, cannot afford to allow any of its own food-producing capabilities to remain undeveloped.

At the present time the foreign and domestic fisheries of England are considerable, their annual value being estimated at not less than five or six millions sterling. One person in London trades in salmon to the extent of thirty or forty thousand pounds per annum. Another London trader does to the value of fifteen thousand pounds in lobsters, while other edible fish are sold in like proportion.

The following list will give some idea of the extent to which various fish is used in England. There are sold in the London Markets yearly—

WET FISH.

Description of Fish.	No. of Fish.
Salmon and Salmon-trout	406,000
Turbot	800,000
Brill and Mullet	1,200,000
Live Cod	400,000
Soles	97,520,000
Whiting	17,920,000
Haddock	2,470,000
Plaice	33,000,000
Mackerel	23,520,000
Fresh Herrings	175,000,000
Ditto in bulk	1,050,000,000
Sprats	120,000,000
Eels	9,797,000,000
Flounders	259,200,000
Dabs	270,000

SHELL FISH.

Oysters	495,896,000
Lobsters	1,200,000
Crabs	600,000
Shrimps	498,428,648
Whelks	4,493,200
Mussels	50,400,000
Cockles	67,392,000
Periwinkles	304,000,000

The rapid transport which the recently extended railway communication has given has vastly increased the fish trade, and raised the price of fish considerably, especially near the coast. Now, as all the varieties of fish having the greatest demand in the London market are found in Devonshire, and our railway communication being complete, not only to London, but to the populous midland counties, we are offered the strongest reasons to do our best to develope and increase those privileges of nature with which a kind Providence has so bountifully endowed us.

In considering the favourable position of Devonshire for fish cultivation, it will be seen that nearly all kinds of fish most in demand in the London markets are taken in Devon, its 400 miles of river, and its 200 miles of coast, offering all the variety of deep and shoal water, and of muddy, rocky, and sandy bottom which the different varieties of fish delight in; so that for *Fresh-water Fish, Sea Fish,* and *Shell Fish*—the three great divisions under which, commercially, fish may be classified—may, and do, all find a congenial home in our county.

Fresh water fish, as far as commercial importance goes, may be almost considered to be confined to the salmon, as its value far exceeds that of all others put together. Trout, eels, &c., may have a local importance; but that is of small consequence compared with the demand for salmon, and need not be taken into consideration in our present paper.

The salmon is here stated to be a fresh water fish; but the truth is, that it is both a fresh water and a salt water fish. It has its beginning in fresh water, but it cannot attain its maturity without going into salt water: hence, it annually migrates from river to sea, and again from sea to river.

For a long time the natural history of the salmon was involved in much obscurity; but recent investigations have thrown considerable light upon it, though, from the several names which it has in its various stages of growth, in different places, there is still a good deal of ignorance on the subject in some localities. Having paid some attention to identify the fish in its different stages in our own rivers, I venture to give a sketch of its transformations under the names by which it is known in the rivers of Devon.

The salmon, or *salmo salar* of naturalists, is a migratory fish, living part of its life in rivers, and part in the sea. Beginning its history with its development from the egg, we find it making its appearance about 100 days after the ova have been deposited,*

* Ova of salmon, it has been generally supposed, require from 70 to

which takes place in early rivers about November and December, and in late ones in January and February. At first when the fry are seen they are small tadpole-like creatures, with the remains of the egg attached to their abdomen. At this time they are weak, and swim about in still pools near the edges of rivers, or where the force of the current is obstructed by roots of trees or large boulders. As they grow they get quit of their abdomenal appendage, and their strength enables them to venture into midstream, and besport themselves as other members of the finny tribes. The fry at this early age have many enemies, and fall a prey to these by hundreds. At five or six weeks old they are about an inch in length, are shapely, and can pretty well look after themselves. At this period the salmon fry much resemble the fry of the common trout, but the former may always be distinguished from the latter by the absence of a bright vermillion spot on the adipose fin, which the young of the trout always has. They do not, however, grow very fast. At six months old a salmon is not above half as many inches long, while at a year old he generally measures from five to seven inches in length, and in our rivers he is called a *hepper*. It has been the habit for anglers to kill them at this stage in large quantities, though there is an express law against it—believing them not to be salmon, but a distinct fish, a belief that is by no means uncommon even yet.

At this stage the salmon undergoes a remarkable change; he rather suddenly assumes a new dress, which gives him a different aspect, and under which he is known in our Devonshire rivers as the *graveling*. The hepper and the graveling have generally been held to be different fish, because, say those who believe so, "we catch both fish in the river at the same time, and the fish are of the same size; nay, the hepper is sometimes the largest." Such, indeed, is the fact; but still they have been proved to be the same fish. The hepper is of a dark greenish colour on the back, with bands, like finger marks, of the same tint running down the sides, while the belly is of a yellowish white. The graveling is a light greenish blue on the back, with no appearance of the finger marks, and the sides and belly are of a fine silvery white. The scales, which give this new

120 or 130 days to hatch; but this would, probably, be under water at very low temperature, possibly from little above freezing to 35° or 38° for a longer or shorter portion of that time, and thus the hatching would be much retarded. At a temperature ranging from 42° to 48° ova have hatched at 60 or 70 days.

appearance, are very deciduous, and, if slightly handled, come off and expose the dark bands beneath.*

With this change, from the hepper to the graveling stage, there appears also to be a greater strength and activity acquired by the fish; and one of my angling friends informs me, that he can tell by the different manner they rise at the fly which fish it is. This change of covering, however, is indicative of a still greater change, viz., that of their fitness to go to the sea; and their new scales are probably an armour to enable them to bear the stronger medium of salt water into which they are about to venture. After attaining the graveling stage, they soon leave the river and take to the sea. One other remarkable fact connected with their history at this period is, that only *a portion* of the fry at this age assumes the graveling dress, another portion retaining the hepper appearance till the next season. This is, perhaps, one of the most singular phenomena revealed by the more accurate observations made on the natural history of this fish, viz., that of two salmon spawned at the same time, one may visit the sea and become a peel of 4 lbs., while the other remains in the river a hepper of an ounce or two; and in the succeeding year one may be a fine grown salmon of 12 lbs., the other only assuming the scales of the graveling, and passing down the river to pay its first visit to the sea. This will explain to anglers, who say, "that while they catch heppers all the year round, they do not catch graveling, and therefore the two cannot be identical," how it comes that they do so, without involving the necessity of considering the two fish being of different species. By far the greater number of heppers, however, go to sea the first year. Those that remain behind assume their graveling dress at the same period the next year—generally about April and May—and

* To a knowledge of the great changes undergone by the salmon in its growth from the ova to the adult fish, we are chiefly indebted to the Stormerfield experiments. In the Scotch rivers the hepper is called the parr, and the graveling the smolt, while the salmon peel of our rivers is there called the grilse. Perhaps it ought to be here stated, that I have considered the salmon peel to be the young salmon, without that direct proof which they have in the Scotch rivers for considering the grilse so. In the latter case they have marked the smolts with wire rings and otherwise, and found them return grilse. I cannot find that there is any such direct proof of relationship in the case of the graveling and salmon peel. I have assumed, however, the salmon peel to hold this position: 1. From its general similarity in appearance to the grilse. 2. From its being the only fish in our rivers that can be supposed to occupy this place in salmon history. And, 3. From the opinions of the oldest and closest observers amongst the fishermen on our rivers coinciding on the point, that the salmon peel is the young salmon.

then go also to the sea, having made little or no progress in growth during the year they have remained behind in the river. It is said, that those which remain the longer in the river are always males.* Having, then, seen the fry become a hepper, and the hepper become a graveling, and traced the graveling from the river to the sea, weighing at the period of his exodus about six or seven ounces, we have next to learn what takes place in the new medium into which it has entered. Hitherto we have seen that its growth has been slow,—now it becomes surprisingly rapid; for, in the three or four months which the fish remains in the sea, it grows at such a rate that, when it again comes into the river, it may be from 2 to 6 lbs. weight, and is known with us as a salmon peel.

The sea feeding must be exceedingly favourable to promote such extraordinary growth, and this rapid growth takes place during each visit the salmon makes to the ocean. It is supposed that they do not go far from the mouth of the river, as, by marking the fish, they have been found to return again to their native streams after each migration.

The first voyage, then, brings a graveling back a salmon peel. The great bulk of these do not enter the river before the summer is well advanced. At this age they begin to propagate their species, though they are less prolific than older fish. It is stated that a salmon produces 1,000 eggs for every pound of its own weight, so a salmon peel 5lbs. will produce 5,000 eggs, while one of 10lbs. weight will give us 10,000 eggs.

There are several points in the history of the salmonidæ that are, as yet, by no means settled, and one of these is, whether or not many of these breed yearly, or only in alternate

* An interesting Paper was read by Dr. Davy on this part of the history of the salmonidæ, at the recent meeting of the British Association. He says that the young of the salmon in its parr-stage has in the instance of the male the testes fully developed, so as to be capable of impregnating the ova of the adult fish. Remarkable and curious as this must be admitted to be, it is the more so, considering that in the female parr of the same age the ovaries are merely in their rudimentary state, and are, indeed, so small, that they may readily escape observation, and give rise to the opinion that the parrs are exclusively males. It need hardly be said that this is not the case; and Dr. Davy says that he can state with confidence, from observations he has made, that the number of the two sexes are much the same. He further states that it is noteworthy in the history of the male parr (male hepper), that it discharges its milt before it descends to the sea as a smelt (graveling). In no instance has he examined smelts when migrating seaward that he has found their testes otherwise than shrunk, from which he infers that the male parr exercises the generative functions.

years. The general opinion is, that their fertility is continuous from year to year; but there are some who believe that they breed rather in alternate years, or at least not in successive years. This is inferred from the state in which the testes and the ovaries are met with in some fish during the breeding season, the former, in such cases, showing little more than as slender cords or threads, while the latter appear merely as granules. This is a question that will be difficult to settle, as it is not easy to see how sufficiently accurate observations can be made to prove the truth of either side.

The proximate causes which prompt animals to change their place of residence at certain seasons, it is not very easy to ascertain; but it is said that the salmon, after remaining in fresh water a certain time, becomes infested with parasites, which attach themselves to its gills, and that these are immediately destroyed on its entering the sea; on the other hand, after it remains there a while, it is attacked with another species, which drives it for relief into fresh water. Probably, also, the instinct to propagate has some influence here; as, after salmon enter the rivers, they soon begin to make their way up stream to those shallow currents and smaller tributaries, where they find favourable spawning grounds. Though some fish enter the rivers earlier, the main influx of breeding fish generally takes place about August and September. At this period the upper waters are generally low, from the summer weather having dried them up, and so the fish remain in the lower and deeper parts of the rivers; but when the first floods come down, they at once make their way to the spawning places.*

The spawning then commences about November, and continues till about February, and this routine of operations goes on annually.

We have shown that the fish come into the river and spawn in their first season as salmon peel, and are then probably not more than 4 lbs. or 5 lbs. weight. After spawning they again return to the sea, without having much increased in weight and return next time of from 10 lbs. to 16 lbs. weight, growing at the rate of about 2 lbs. or 3 lbs. a month in salt water. It is difficult to say up to what age salmon grow, but they have been captured of 40 lbs. and 50 lbs. weight, so that they probably increase up to seven or eight years of age. We may learn from this how destructive it is to capture the fish at an early age.

* As the fish are caught chiefly in the lower parts of the river, and are required to be saved in the higher parts, conservators will have some difficulty in reconciling these conflicting interests.

I have shown, that while the spawning grounds are in the higher parts of the streams, the chief fishing goes on below, and hence there is a diversity of interest between those who breed the fish, and those who can legally capture them. The seed is sown above, and the harvest is reaped below. Those who sow do not reap. What, then, is more natural than that each should only consider their own interests, and, as a consequence, that both processes should be ill performed. Those who sow say, that "The fish are never allowed to reach us till the law prohibits us from killing them: why should we incur trouble and expense for the people who do their utmost to intercept the fish as they come up to us?" On the other hand, those that reap say, "The people above will take no care of these fish; let us capture all we can—careless of the future—sufficient for the day is the evil thereof." And so between these conflicting interests, the true benefits of both are impaired. The crops yearly become poorer and poorer, and the grounds end in becoming absolute sterile. Heppers and graveling are protected legally from being captured, but salmon peel can be legally taken, and yet the sacrifice of taking this fish at such an age is such that no prudent man would desire, especially when fish are scarce. Until recently, the natural history of the salmon was very imperfectly known; but the great attention which has been paid to its artificial propagation has enabled us to understand it better, and the lesson we ought to learn from it is, that if we would have it plentiful, we must carefully protect it in the stages of its earlier growth, which unfortunately has not been the case in Devonshire. In our rivers the hepper, the graveling, and the peel have all been taken, and while an ignorance of their true character prevailed, this was to some extent pardonable; but now that their true place in nature is known, every one ought to feel an interest in preserving them with the strictest care.

In considering our resources in *Salt water fish*, I have already stated that Devonshire produces all the chief varieties of fish of considerable marketable value. The herring and the mackerel are both taken in abundance. It would be difficult to suggest any measures for their increase, excepting that of carefully avoiding such means of capturing other fish as may destroy or injure their spawn, Formerly it was believed that the herring was a native of the north, and that they migrated here at particular seasons. This view is not now entertained. It is now known that the herring is a local fish, and that at those times when it comes inward, it comes to

deposit its spawn in shallow water near the coast. After it has spawned, it again retreats into deep water. The fry, after leaving the egg, move about in the shallow spawning ground till they attain a few inches in size, and then take to water somewhat deeper, where they feed on animalculæ and small crustacea, and become, as some maintain, the *sprat* of commerce, afterwards changing into the full herring. How long the herring takes in passing through its changes is not known. Some say one, some two, and others say even seven years are required to complete its growth; but its natural history, like that of many other fish, is yet imperfectly ascertained, for it is by no means settled whether the sprat is the young of the herring, or a distinct fish. Let us hope, as our piscicultural science advances, we shall have some of the creeks of our coast turned into salt water breeding ponds, which will enable us to determine this, as well as other knotty points of fish history.

In connection with the herring, it may be mentioned that the *whitebait*—another member of the family *clupeidæ*—is also found in Devonshire. This fish has had many opinions delivered upon it, as to what it really is. It has been said to be the young of the herring. Fleming says that it is the young of the chad, and Yarrell has taken some pains to prove that it is a distinct fish. But whatever it be, I believe the same fish which is taken in the Thames is taken at the mouth of the Exe. It is generally thought that whitebait are confined to the Thames, but this is not the case; for it has been shown that they are taken at Southampton, in the Frith of Forth, and I have the authority of Mr. Couch for saying that they are found in the Fowey river in Cornwall. Why, then, may they not be found in the Exe? Two years ago, some trouble was taken by the Exeter Naturalists' Club to determine if this fish was the same as the whitebait. Some specimens were sent to Professor Owen, who submitted them to Dr. Gunther, the great fish authority at the British Museum. He declared against their being the whitebait, because he thought they wanted certain teeth which the whitebait had; but on a microscopical examination by some of the members of the club, they found the Exe fish had these teeth, and on submitting them to Mr. Couch, he declared them to be the same as the whitebait of the Thames. So amongst the other piscicultural wealth of our county, I have no hesitation in ranking that of the whitebait. The turbot, the brill, the sole, all fish of great marketable value, are taken on our coast to a considerable extent; and a question very

forcibly arises, whether or not all these might not be increased by artificial culture. The haddock, the whiteing, the plaice, flounders, dabs, &c., &c., are also bred plentifully; and that useful but not much valued fish, the hake, is a common denizen of our coasts. This enumeration of our salt-water treasures ought to impress us with their importance, and prompt us to give all that attention to their development which increased experience and advanced scientific knowledge are able to point out.

Again, nearly all varieties of shell fish find a congenial home on the different parts of our coast. The lobster and the crab, the shrimp and the prawn, the mussel, the cockle, and the limpet could, with attention, be produced in any quantities; while that mollusk par excellence—the oyster—might with care be found on our coast as

> "Thick as autumnal leaves that straw the brooks
> In Vallombrosa."

Notwithstanding this character of our coasts, as offering favourable haunts for so many varieties of fish, there is every reason to believe, the productiveness of our sea fisheries are gradually decreasing, while our salmon fisheries have already become nearly, if not altogether, valueless.

Possibly such fish as the herring and the mackerel, which appear annually in countless hordes, continue to come much the same; but all those which inhabit a zone nearer the shore, and appear in limited numbers, have decreased.

As I have said, Devonshire-caught salmon have ceased to be an article of commerce in the county; for I do not know a fishery now carried on in any of our rivers, though there may be one or two of which I am unaware. For this decrease of salmon there are several reasons, the chief being probably the introduction of mine water into our rivers. But this cannot be the only one, since the rivers into which no mine water has come have lost their salmon. There was a time when the tradesmen of Exeter were required, by an express stipulation in their indentures, not to give apprentices salmon above two or three days per week. Now, salmon rarely gets under 1s. 6d. per lb. in the city, 2s. 6d. being the more general price. No doubt the increased demand for fish which has taken place in late years, has done much in raising the price; but, independent of this, the fish have decreased in numbers. Until the present season, when a little more care has been taken of the fish,* a salmon has been a rare fish in

* The conservators of the Exe have, for the last ten years, exerted themselves to protect the young salmon in this river. One gentleman has

the Exe for some years past, and so it has been in most of our Devonshire rivers. From the observations made on the Natural History of this fish, it will be seen to what dangers they are exposed before they arrive at their full growth. In the ova and fry state, they have been left entirely exposed to all enemies, and in the hepper, graveling, and salmon peel stages, fishermen have taken them without compunction; while the *back-fish*, or such fish as have just spawned, have also been slaughtered, and sent off to the London or foreign markets in great numbers. At all these periods, the fish have been killed to a great disadvantage, which has ultimately resulted, with other causes, in nearly exterminating the breed in our rivers. But the impurities introduced into our western rivers from mines—the Teign for instance—have rendered their waters so thick and injurious to life, that in some places fish cannot exist; and unless some means can be devised for cleansing them, all expectation of having salmon or any other fish must be given up.

Formerly, we possessed several oyster beds on our coast, now, nearly all, if not all, of these are gone. The last bed that I heard of, was one discovered between Dartmouth and Kingsbridge. Immediately its existence became known, dredgers came from all parts for a share of the spoil, and in a very short time, all the oysters were taken away. The last account that I heard of the bed was, that a steamer had come, and was endeavouring with all her superior power to try and scrape up any that might have been left. The native oysters that used to be found near Exmouth are also all gone. There is also reason to believe, that this mollusk is scarcer in the neighbouring county of Cornwall than it used to be. A gentleman, who has given attention to oyster culture in Devonshire, says that the native oyster of the river Exe has become nearly extinct from over-dredging—dredging being carried on at all times and seasons, without let or hindrance from the lord of the manor, and further, that the stocks of oysters at Lympstone are almost exhausted.

In the year	1859	they amounted to	12,900	cubic feet.
„	1860	„	9,500	„
„	1861	„	7,440	„
„	1862	„	1,660	„
„	1863	„	none.	

The recent and almost sudden increase in the value of

himself rented one of the fisheries, that the fish may not be killed there; and salmon ladders have also been placed at the weirs, by the corporation of Exeter, to facilitate the ascent of spawning fish, when the water is low.

oysters at Falmouth (whence the dealers at Lympstone usually obtain their stocks) from 2s. to 16s. the tub, is stated by them to have obliged them to discontinue importing them. Oysters laid down at Lympstone do not generally renew the beds with their own young, the oysters here being imported, and laid down to grow or fatten. The ground at Lympstone is chiefly mud, and some writers on the oyster assert, that oysters on mud-banks fatten well, but do not breed. But it was nevertheless found, that at least one oyster in every twenty in those beds showed spawn in the months of September and October of 1862. The native oyster breeds freely in the channel of the river Exe; but the spawn of the oyster in the Lympstone beds, being deposited on the mud-banks, is almost immediately destroyed. There is every reason to believe, however, that with scientific culture, the spawn might be preserved, and that the river Exe might easily become a nursery for oysters. Mr. Barry, one of her Majesty's Commissioners of Fisheries in Ireland, reports the coast from Exmouth to Brixham as favourable, and most excellent for the cultivation of oysters. The value of the oyster having largely increased, it is most important that the capabilities of our rivers, as well as our coasts, should be carefully considered, and especially so by the lords of the manors.

Some years ago, a considerable trade in mussels sprang up between London and Starcross; but the fishermen there acted so imprudently, and sent so many at once to market, that they destroyed their stock, and have not yet fully recovered it. The Dutch, however, have in the mean time come in, and now supply this fish in any quantities, bringing it over cheaply with the turbot, soles, and other more valuable kinds, with which they supply the London markets. To this reckless and imprudent drawing on the future, is to be attributed much of the present scarcity of fish in Devonshire. All sizes are taken that come to the net—people who cannot afford to buy the large ones, buy the small ones, and this holds good, not only with the commoner, but also with the more expensive kinds, such as turbot, soles, brill, lobsters, &c. If the fishermen are spoken to on this destructive policy, the only answer you get is, "What is the use of throwing any back again—if one does not take them, another will."

The last point we have to consider is the best means of improving our fisheries. These means appear to rank themselves under the following heads: 1. *The use of less destructive modes of capture.* 2. *Stricter attention to fence months.*

3. *Proprietorship in coast and river property.* 4. *Artificial propagation.*

By many modes of capture now pursued, not only fish of proper size are taken, but also large quantities of very small ones. This is not only caused by using a net of too small a mesh, but also by small fish being brought up entangled in weed, and not carefully thrown back again. The law has regulated the size of mesh,* but no law can prevent the small fish from being entangled in the weed brought up by nets of every sized mesh, and unless there is a *direct punishment* for destroying small or young fish in any manner, the evil will never be wholly cured. To effect this, a good supervision must be placed over fishermen, in the form of a police, to bring offenders to justice; and a force already organized offers itself in the Coastguard. This body of men have now no duties—as far as smuggling goes—to perform, and, from their position and complete organization, offer at once a most perfect means of supervising fishermen on all parts of the coast, and enforcing any regulations that may be deemed advisable to adopt for their control.

It has long been held by many persons, that the system of *trawling*, especially near the shore, is exceedingly injurious to the fishing grounds; and very recently I was informed by an exceedingly intelligent coastguardsman, that fish were much scarcer now than they were formerly, because of the destructive character of trawling. He had seen "bucketsfull of spawn" destroyed in this manner, and he believed wherever trawling was carried on, fish never could become plentiful. I consider this evidence extremely valuable, both on account of the intelligence of the witness, his great means of observation, and also because he had no pecuniary interest one way or the other in the matter.† Fish generally spawn near the shore, and the fry remain there for some time, and these have been found to be liable to very serious destruction even from shrimpers with their small hand-nets. Francis states that he has seen taken from a small poke-net on the Sussex coast as many as from ten or a dozen to fifty fry of soles, turbot, plaice, or flounders, of from an inch and a half to two inches long, and this occurring every time the net is emptied. So, where many of these nets are at work, it is not difficult to imagine the great destruction they will cause, if they are not

* Act of the 1st George I.

† There is a difference of opinion on the injurious effects of trawling. Probably the reports of the Commissioners, when published, will give us the means of coming to some just conclusion on the subject.

careful to allow their rubbish, amongst which is mixed the fry, to fall back again into the sea. But to see that this is done is nobody's business, and hence it is too frequently not done at all, and the fry are allowed to perish, as if they were of no importance.

Another source of loss is that of capturing too small fish. In the lobster trade two small ones are counted as one large one. The fishermen themselves allow the improvidence of this method; but they say, "If one does not do it another will, and so it's no use throwing any back into the sea, as long as others will take them out."

In questioning some fishermen lately on the Cornish coast, I found they seldom threw any fish back into the sea. I am now referring more to shell fish, crabs, lobsters, &c. Two small ones are counted for one large one. The mode in which they dispose of their fish is this: they agree with a house in London, Southampton, or some fish trading town, to take all they capture at such a price per dozen. Crabs and lobsters usually run from 10s. to 12s. per dozen. The pots are set one day and taken up the next, and what are caught are placed in some general pot, and kept sunk in the sea till the trading vessel calls for them. This vessel usually comes once a week, and takes away the week's accumulations. If, as in some cases, they are sent away by rail, then they keep the stock till a certain time, when it is sent off properly packed. By this means fish is hardly to be had by a chance visitor to these small fishing villages, and the residents informed me that occasionally a fish might be procured as a favour; but that was not common, as all that were caught were understood to belong to the dealer who had agreed for the purchase of the stock. The fishermen all, however, agreed that if the young fish were allowed to grow larger, it would certainly be better; but none liked the idea of practising such self-denial, as throwing any back into the sea. The strong arm of the law, I fear, will be the only remedy for this short-sighted policy, which must dictate the size of the fish that is allowed to be legally taken.

The next point, or that of paying stricter attention to the fence months, is one of great importance. At these times the fish are about depositing their spawn, and so increasing their numbers some thousandfold, or are so debilitated by this act as to be in the worst possible condition for food. To kill them, therefore, at either of these periods is the worst possible economy.

We have less control over sea fish at such times than we

have over those which spawn in rivers; but still there are cases where we knowingly and willingly commit destruction where we need not. The lobster is an instance. We kill them when the female is full of "berry," and esteem them most at this period. If these fish were allowed to deposit their ova, or "berry," we should have a corresponding increase of young fish. The amount of young must be greatly limited by this mode of capture, which might easily be altered, if a female fish, which is near "shooting her berry," was not allowed to be taken.

The recent attempt to give a *property* in the fishing at Herne Bay, and the opposition it has met with, renders it probable, that any legislation for giving exclusive fishing rights to any particular persons would meet with a wide and strong condemnation; yet to me it appears one of the necessary preliminaries before we shall ever get our coast fisheries into a satisfactory condition. I say coast fisheries, in contradistinction to deep sea fisheries, which may require other regulations. It does not, however, appear to be establishing altogether a new principle, since lords of manors have always claimed certain rights in the fishing adjoining the coasts of their manors, though they may not always have enforced them; nevertheless, it is a point worthy the gravest consideration, and the discussion provoked by the Herne Bay case must prove of great advantage, as it will draw attention to the subject, and set forth all the *pros* and *cons* that can be advanced upon it. While the old commons were left for the use of every one their cultivation was neglected, and their produce almost nothing; but, since individual rights have been given in them, they do not now look barren spots in a fertile country, but yield crops equal to the other lands of the district.

In savage life, when a few wandering hordes only occupy a country, they subsist by killing the animals that nature provides for them; but, as civilization advances, this mode of procuring food becomes uncertain, and it is soon found necessary to keep flocks and herds, and breed cattle, artificially, if I may so speak, to meet the demands of a growing population. Such is the progress of man from rude to refined life. The savage takes nature as he finds her; the advanced man so studies and makes himself acquainted with her laws, that he can divert them to his own purposes. The nut, the berry, the fruit, or the root which the savage finds in the district over which his tribe ranges, are the vegetables which supply his daily food; while civilized man has his table stored with every fruit of every clime. By the study

of nature's laws he can, by certain appliances, grow in his own country the luscious pine of the tropics, or congeal water so as to give him the crystal ice of a polar sea. So in civilized England our food is as varied as our appetites; we have brought our vegetables from all climes, and breed our cattle with the most scientific accuracy, yet we have left the inhabitants of our rivers and our seas much the same as they were in the time of the ancient Britons. We have not even learnt of the ancients in this matter, and are now only beginning to feel that it is not necessary that salmon should be 3s. per lb., and oysters only be known as a fossil in England. In Devonshire we have toiled on the surface of the earth, and under the surface of the earth, to eke out our riches; we have sought to make the barren torrs of Dartmoor wave with golden grain, and have defaced the surface of many a fair scene to obtain wealth from below, but we have neglected to turn to account that "waste of waters" by which we are surrounded as a profitless desert, but which, properly cared for, are likely to prove as valuable as the land which they surround.

For some years past, we have heard mutterings of something called pisciculture; and very recently "all London was running to see young salmon growing from the egg, in a glass bowl, in a window in the Strand;" yet the Chinese, that nation which we look upon as in a state of barbarism, "carry on fish-breeding to such an extent, as to be able to keep up a supply of the fish that inhabit their seas and rivers, so as to afford to sell any quantity of food of this kind at the rate of 14 lbs. for 3d." We are told that nothing surprised a Chinese so much, on a visit to Europe, as the price he was charged at Toulon for a fish breakfast. Further acquaintance with the Chinese mode of practising the art, shews to what a great extent it may be carried; and already, in many parts of Europe, people are beginning to see the vast importance of fish culture as a national object, and are adopting it. The French have established large breeding ponds, and in France it has become a great national question. At Stormontfield, in Scotland, pisciculture has been for some time carried on, and has settled some interesting questions in salmon history; and although it has only been on a very limited scale, yet, from its operations, the rental of the river Tay, a great Scotch salmon river, has already been increased ten per cent. Here, then, by artificial breeding, we have a means of increasing fish to any extent, where we have rivers, ponds, or sea coast; and the time is not far distant when the value of these possessions will be ranked, acre for acre, equal to that of land. It is not

my intention, in the present paper, to enter upon the modes practised in pisciculture—these may be learned from the works of Francis, Buckland, and others—but to call attention to the subject generally. My remarks, therefore, are intended to be suggestive, rather than anything else, in the hope of fixing attention more closely on a subject just being introduced to English thought. It is rather remarkable that it has not before had greater consideration in this country. As a food question, in a nation whose population far exceeds its means of production, it is eminently important; and as a commercial speculation amongst a community of traders, it is singular that it has not had many "promoters" long before now.

Fish-breeding in Devonshire, then, ought to be set about at once. In our rivers not contaminated with mine water, we have the best opportunities for salmon culture; and the possessors of these rivers might easily, by a combined action, develope their property in this manner to a great extent. The process is simple, and not expensive. But all the owners of a river ought to combine, or some difficulties may arise very detrimental to complete success. Enough has been done in salmon breeding in England, or rather Scotland, to show its feasibility, and nothing is wanting but earnestness of purpose to realize all the results that it promises.

Again, it has been authoritatively pronounced that some parts of our coast are eminently fitted for oyster culture; and gentlemen possessing manorial rights in the estuaries of rivers, might assist greatly by encouraging in such places the growth of this fish. A London company has been established for carrying on the breeding of oysters in the Thames, and we know that on the eastern coast there are many very productive oyster beds. This fish is becoming dearer yearly, and so its cultivation promises the most profitable results to persons who are willing to undertake its culture in our county. The cultivation of the lobster and crab, as well as many other kinds of sea fish, is yet to be set about, and the various creeks and small bays on our coast offer great facilities for such attempts.

The sole is a variety easily experimented upon. We know that it will live and grow a long time in fresh water, and water of a brackish character may not be unsuited for its breeding. It is a most useful fish, being in season nearly all the year round. It spawns in March and April, and is then for a time out of condition and unfit for food; but it soon recovers itself, and again becomes marketable. This fish is

often killed to great disadvantage, for it is frequently seen on sale not larger than a small hand; yet it grows to a large size. One was sold in Totnes market, in 1826, twenty-six inches long, and I saw one in Cornwall, a week or two ago, nearly two feet. There are, no doubt, other fish that might be experimented upon; for as yet fish culture, in this country at least, is in its infancy, and we scarcely know the extent to which it might be carried. We ought to have salt water ponds established for the purpose of experiment, and it is only reasonable to think that these experiments might be fairly assisted by Government. Think what profitable results are promised by breeding fish. No animals that we know of are so fecund as fish, except perhaps insects. One lobster has been known to carry under its tail 18,000 berries. Salmon produce at the rate of 1,000 ova for every pound in weight; and the same character of increase prevails throughout the fish kingdom. One gentleman says in the *Times:* "I have now hatching in my greenhouse the following:—Salmon, 15,000; salmon trout, 900; great lake trout, 2,500; hybrids, between salmon and trout, 3,000; a new fish from the Swiss lakes, 4,000; English trout, 97,000; and French trout, 4,800." Now, think what can be done in extensive waters, when a gentleman breeds this quantity in tanks in a greenhouse. Furthermore, he tells us: "Last year I was enabled to turn out alive into the river 95 per cent. of eggs placed in the boxes. This year I trust even to do better than last."

Surely, then, such results ought to stimulate us, who are surrounded with natural waters of the most favourable kind, to examine this new science with care, and endeavour, if possible, to avail ourselves of its advantages. We have brought plants from every clime; why should we not also introduce new fishes? The even temperature which water preserves through great changes of atmosphere, would probably enable us to do great things in this way. In fact, the whole subject is new, and offers so wide a field for speculation, that we can hardly tell where it may not lead us. Let me express the hope, then, that I have said enough to show that, with the great water privileges which Devonshire possesses, and the promises which Pisciculture holds out, that it is incumbent upon all of us who are anxious to benefit our county, to give the subject of the Fisheries of Devon our best consideration; for if he be considered a good patriot who makes two blades of grass grow where one grew before, he cannot be considered less so who adds a hundredfold of fish-wealth to our present depopulated waters.

THE PILE DWELLINGS IN THE LAKES OF SWITZERLAND.

By E. Vivian, M.A., etc., *President of the Devonshire Association.*

Having just returned from the exploration of the antient lake dwellings in Switzerland, in company with Professor Phillips and Mr. Lee, of Caerleon, high authorities in geology and antiquities, I can report to you the latest information from those extremely interesting regions. The early history of these researches extends back more than half a century. During that period, and especially in the unusually dry season of 1858, a vast number of these settlements were discovered, and the remains collected by the Swiss antiquaries. Those which we had an opportunity of visiting were in the Lakes of Zurich, Moosseedorf, near Berne, and Bienne, where, through the kindness of Dr. Keller, Dr. Ullmann, and Col. Schwab, who had respectively superintended the explorations, we had an opportunity of fully examining their magnificent private collections, examining the localities, and hearing their own descriptions and opinions. The positions of the settlements were on the borders of the lakes, and they appear to have been constructed on piles, with cross beams and wicker work, generally of the rudest kind, and it is supposed that the only access to them was by a narrow passage, and, perhaps, a drawbridge. The description of similar villages on Lake Prasius, as given by Herodotus, principally for defence, has led to the general belief that these were of the same character. On examining the localities, however, which were frequently on a level, or even commanded by higher ground in the immediate vicinity, no engineer, even in the flint arrow period, would have made so injudicious a selection. The prevalence of implements suited for fishing, and the chase, and domestic purposes, seemed rather to point to their use as fishing stations, during possibly a portion of the year; the remains of corn, apples, and other fruit, with bones, as it is supposed, of domesticated animals, making it more probable that their ordinary residence was on land, amongst the rich pastures and wooded hills in the neighbourhood. At Moossee-

dorf the remains were found in a bed of black peat, about ten feet in depth, which was covered by about two feet of soil, which has long been under culture; on lowering the level of the small lake by drainage this portion was laid dry. The peat was carefully excavated, under the inspection of Dr. Ullmann, whose residence is near the spot, and the contents carefully stored in his private museum. Amongst these were the ordinary flint flakes, with one smooth and one ridged side; some with points, as for arrows; others with cutting edges; and a great number rectangular pieces, about one inch by a quarter of an inch, which appeared to have been used as ornaments, or, possibly, weights for fishing lines. Flint implements of every gradation were also found, down to the highly finished barbed arrow heads, similar to those found in the English and Irish barrows, and still in use amongst the South Sea Islanders. There were also vast quantities of large flat pebbles, ground as for axes, and some partially split longitudinally by the flint saws which accompanied them. One was carefully soldered together with pitch. Horn sockets were found, into which these fitted; some still attached to wooden handles, generally of oak, about fifteen inches long, of which Dr. Ullmann had taken a cast when first discovered, but which, on drying, had shrunk into a quarter of their original dimensions. He shewed us a stone of similar quality with the implements found in the lake, which he had ground down upon one of the slabs of sandstone, and he found that it took about ten hours of continuous labour to form an axe. Stones were also found perforated as for weights to nets, and many other purposes.

Of nearly the same pattern with the most carefully wrought flints were *bronze* implements, ordinarily known as Celts, similar in form to those from Ireland in the Torquay Museum; rings, and a multitude of small articles apparently used as ornaments; an amber bead, precisely similar to those which I discovered in Kent's Cavern, was found at Miclen, and is in the museum at Berne. In Col. Schwab's collection iron implements predominated. These were of very various quality, both in regard to metal and workmanship. The rudest were perforated square weights, similar to one recently found in Kent's Cavern, adzes, bill-hooks, knives, shears connected by a spring, as those now used for sheep-shearing, pins, nails, a trident, barbed probably for spearing fish, and a vast series of swords, daggers, and lance heads. Some of these were in excellent preservation, and could not be surpassed by the finest Damascus blades, the grain of the iron

shewing that they were made of welded shreds, as our best gun barrels. They are still quite elastic, and were readily drawn from the sheaths, which are also of iron. The patterns of these are decidedly Roman, highly wrought and ornamented, but no distinctive mark could be found of their having belonged to any Roman Legion, neither were there any inscriptions to prove their origin.

Pottery abounds in some of the deposits, of every character, from the rudest fragments of vessels moulded by hand, to highly glazed and ornamented Samian ware, turned upon a lathe, with large amphoræ, some almost entire, of distinctly Roman pattern and workmanship. The most remarkable object, amongst apparently the earliest specimens, was a crescent, somewhat flattened at the base, with upturned horns. Col. Schwab possesses one, about a foot in length, curiously marked with a row of indentations and perpendicular stripes, produced by human fingers. The impression of the nails is clearly seen, and the whole character and size is that of a small man or woman's hand. This emblem promises to afford some clue to the relative ages, and perhaps nationality, of the entire series, as it occurs in the rudest pottery, and also in bronze. Ornaments or badges abound, most of them having ornamented handles, with holes, as for suspension. I also found the same emblem stamped upon the sword blades. Col. Schwab had also observed this, but I do not find it mentioned in any published reports. It appears to be impressed by a die, of about a quarter of an inch in diameter, as our Tower mark, or the initials of the maker on Roman implements. The crescent form prevails throughout, but on some there were other distinctive markings, and, upon the finest blades, a small circle in the centre of the crescent, with, what in heraldry would be called, three bezants, or rings. Might these have been the armorial bearings of some tribe or primitive canton, and might the armourers have been Phœnicians, or the early Greek colonists at Massilea, who worked to order for all the markets of the world, impressing not their own, but their customers' marks upon their manufactures, and copying, indiscriminately, the patterns and designs of other nations?

The earliest traces of pictorial art are supposed to be found amongst the remains recently discovered in the caves of central France. I saw some, now in the British Museum, with heads and antlers of the reindeer distinctly scratched upon bone and horn. In the lake deposits are probably the earliest specimens of sculpture. At Bienne was found a

model of a small animal, apparently a beaver; and on the pottery, though apparently of later date, are lions and other animals.

The only human remains found by Dr. Ullmann were those of a child, which he supposes might have fallen into the lake, the precaution which Herodotus mentions, of tethering the babies by the foot, not having been taken. Colonel Schwab has several very perfect skulls, and almost entire skeletons. The teeth, especially of a young subject who had not yet cut his wise teeth, were ground down, as those in Kent's Cavern, which antiquaries attribute to the first introduction of coarse bread, after the hunter period; but the incisors were not injured, as those from our caverns and the earliest Barrows always are, and which is supposed to arise from some superstitious rite, as still observed in the Indian Archipelago. The skulls are rather short, with low foreheads, but present no remarkable configuration. On a general review of the lake dwellings, the highest antiquity appears to be assignable to the remains in the east of Switzerland, stone and bronze predominating there, whilst bronze and iron are principally found in the western lakes. From internal evidence there appear to be three well-marked periods—the stone, the bronze, and the iron; but I could not ascertain that there was any definite proof of this from the order of superposition, all the explorers assuring us that the remains were found indiscriminately distributed through the peat and lacustrine deposits. Such was once supposed to be the case in our caverns, but the examination of Brixham Cave proved that there was a clearly recognizable order in the deposits, if carefully worked. These several periods doubtless passed into each other, stone being used long after the discovery of bronze, and both continuing through a portion at least of the iron age. Possibly we may discover in this a distinction of ranks. The negro chiefs possess firearms, whilst their subjects use principally bows and arrows. Flint weapons are enumerated by Herodotus in the army of Xerxes. The lake dwellings seem thus to have existed during the Roman occupation; but it is remarkable, if they were of sufficient importance to possess swords and iron implements such as I have described, that they should not be mentioned by Cæsar, or any other Roman author. Some of the swords were jagged, as from hard service against enemies who also possessed iron weapons. These could not therefore have been the swords of the conquerors alone. War leaves its records earlier than peace, so that the subjugation or extinction of these tribes seems to have been altogether

pre-historic. Opinions are divided whether the bones found in these deposits are those of domesticated animals. The plates of restorations published by the Antiquarian Society at Zurich represent an antient lord of the isles in paletot and gaiters—

> "A shaggy, wolfish skin he wore,
> Pinned with a polished bone before"—

with a dog by his side and cows tethered near the pile dwelling, which has a chalet roof! But the only remains which we saw were those of a goat, which had a perforation beneath the horn much more resembling a wound from a hunter than the butcher of the establishment; bones of an ox, more like *Bos primigenius* than the present Alpine breeds (an awkward tenant for a lacustrine linhay); and a dog's skull, which would represent the hunter as well as the pastoral age. Their apples must certainly have been larger than crabs; but these, and wheat, which never has been found wild since the Ægilops' theory was abandoned, may have been cotemporary only with their subjugation.

In these notes I have carefully abstained from committing my distinguished companions to any opinions which they expressed; the subject will be maturely considered, in all its bearings, by Professor Phillips, who, as president of the Geological Section at the meeting of the British Association at Bath this year, will, I hope, give us the results.

Amongst other objects of interest, which I had at the same time an opportunity of observing, was the action of Glaciers. We carefully examined those of Grindenwald and the Sheideck Pass, which have recently undergone great changes of level, and progressed with more than ordinary rapidity. The upper glacier at Grindenwald has sunk nearly sixty feet, so as to be now only accessible, above the chalet, by a long ladder; the markings thus displayed upon the sides of the rock are precisely those which have been observed on Snowdon and the Scotch mountains, where, during what is considered to have been our glacial period, similar groovings and polished surfaces prevail. A massive block of Gneis is now travelling down towards the valley at the rate of from five to ten feet per year, resting upon the perpetual ice, which seems to have undergone but little change since it first separated from the Alp. The Moraines, both lateral and preceding the glacier, were also highly instructive. The curious phenomenon of strata of blue and white ice was very well marked. The cause of this is still a mystery. The most plausible theories

are those which refer it to the development of heat by pressure, or the alternations of seasons. The disruption, upheaval, and contortions of these frozen seas afford a most interesting epitome of the great geological changes which have occurred in the crust of the globe, and which meet us at every turn in the fine sections on the Alpine ranges. The most astounding instance of glacial transportation is the *Pierre à bot*,—a huge mass of granitic rock on the hill to the northward of Neufchatel. Its nearest source must have been the St. Gothard, and the theory is, that it moved across the lake of Neufchatel, which was then occupied, and in fact formed, by a stupendous glacier, at least fifty miles in extent. The relative levels are, however, almost insufficient to account for this, and it has been suggested that great changes in this respect must have since taken place, even a subsidence and upheaval of the entire district, so as to admit of the rock, which weighs about 300 tons, being transported upon an iceberg. At all events there it lies, carefully deposited upon the slope of a lofty hill, scarcely at all buried in the ground, and with no marks of friction or violence.

THE

CLIMATE OF TORQUAY AND SOUTH DEVON,

From Meteorological Observations taken at Woodfield, Torquay.

BY E. VIVIAN, M.R.M.S.

Climate is determined mainly by three causes—latitude, elevation, and the conveyance of heat and moisture by atmospheric and marine currents, dependent upon geographical position. Applying these principles to South Devon, and especially to Torquay, we should expect to find—1. A mean temperature intermediate between the hot and cold climates of the habitable zones, free from the local influences of snowy mountains or arid plains—a Vent de Bise or Sirocco. 2. A limited range, both of temperature and humidity, annual and diurnal, with an average fall of rain, principally during the

autumn; a mild winter and cool summer, with freedom from storms; the direction of wind generally from the south-west.

The following observations fully bear out these expectations. Our average mean temperature has been 50·2; the absolute maximum and minimum extremes during ten years 82° and 18°; but the average range is much below this, the greatest intensity of frost, in 1854, having been only 29°, and the greatest summer heat, in 1853, only 75°, and in 1860, 74°. The annual fall of rain was 28·9 inches, on 154 days,—an amount which, owing to the hilly and porous character of our soil, is, in spring and summer, rather below than above the amount required for luxuriant vegetation.

The character of our winter climate has long been known. Sir James Clark speaks of it as "certainly drier than the other places on the south-west coast, and almost entirely free from fogs—combining in the highest degree all the favourable qualities of the south-western climate." Dr. Granville, in his Spas of England, describes a November day as "genial and pleasant as a clear, calm, and summer evening in the south of Spain." Of the fall of rain there had been no sufficient observations. Mine, which were introduced into the last edition of Sir James Clark's work, give a correct report; but, unfortunately, he omitted to make the corresponding corrections in the text, and the erroneous impression, in regard to the "enervating and relaxing" character of our summer climate, is confirmed by its appearing to rest upon a long series of observations. Sir James Clark originally gave this opinion merely from the few unconnected observations which had been made in the lower parts of the old town, and the character which the whole county of Devon had acquired from the excessive fall on Dartmoor, which Dr. Shapter estimates at no less than 74·31 inches at Holne, and 62·82 at Princetown. In a Paper which I read before the Torquay Natural History Society, as early as 1844, I arrived at the same conclusions, and pointed out the errors into which medical writers had fallen from blindly following Sir James Clark's text, without referring to his tables.

The special geographical advantages which Torquay possesses are principally these:—The line of coast from Exmouth to Start Point runs nearly north and south, hence the east wind, ordinarily the hottest in summer and coldest in winter, is tempered, in both extremes, by passing down the whole length of the Channel, the surface water of which is seldom within twenty degrees of the maximum and minimum of the air. 2. The parching east winds in spring are moistened by

the warm sea, which, on the other hand, acts as a condenser in summer, its temperature being often below the dew-point of the air. This drying influence of the sea is an apparent paradox, upon which I have had some controversy with meteorologists, but it is now generally admitted. The Registrar-General, even in the winter quarter of 1847, reported that "the counties of Cornwall and Devonshire were not only much warmer, but the degree of humidity of the atmosphere was much less than in any other part of the country." This has proved to be the rule, especially in regard to the extremes. The absence of thunder storms and electrical disturbances is very remarkable. During the last thirty years I have never known a pane of glass broken by hail, the invariable accompaniment of heavy thunder, whilst at Beer Head and the high ground of east Devon and Dorset, as also on Dartmoor, lightning and hail are very prevalent. These seem to be the lines of attraction which divert the storms from the intermediate district. The circulation of air, by alternate land and sea breezes, at different hours of the day during hot weather, is also a great advantage. It arises from the peculiar configuration of Torbay, which reverses the lines of the great western bay from Portland to Start Point. The tides, which pass in opposite directions in the two channels, give this character, more or less, to the entire peninsular of the western counties.

As compared with Clifton, North Devon, and still more the alleged bracing localities inland, our summer climate possesses great advantages. We never have a hot wind, excepting from overland, which, being here confined to the north and north-east, is never oppressive. So long as the sea breeze continued during the recent hot period, our temperature never rose above 72°, whilst at Aldershot, a high, "bracing" gravel district, it was quoted at 85°. I confidently appeal to all who have resided here during the summer, whether these impressions are not correct; and, in confirmation of this, I may refer to the presence of members of the Imperial family of Russia, who, with their attendant medical advisers, have again, as in former years, selected Torquay as the most beneficial summer residence in Europe.

SUMMARY OF METEOROLOGICAL OBSERVATIONS TAKEN AT WOODFIELD, TORQUAY,

AND COMMUNICATED TO THE REGISTRAR-GENERAL.

Quarter ending 31st March.

	Temperature: Mean.	Temperature: Highest.	Temperature: Lowest.	Temperature: Daily Range.	Rain: Days.	Rain: Inches.	Humidity: In cubic foot of air. (grs.)	Humidity: Required for Saturation. (grs.)
1851	46·0	58	32	7·8	52	11·4	3·3	0·5
1852	43·5	55	32	7·5	32	7·2	2·8	0·6
1853	40·3	56	24	8·5	32	8·5	2·4	0·7
1854	43·6	57	29	9·0	36	5·0	2·9	0·6
1855	37·5	52	18	7·0	28	5·3	2·5	0·4
1856	43·5	54	28	6·8	35	5·0	2·5	0·7
1857	41·5	53	25	8·3	31	8·5	2·7	0·4
1858	...	56	25	...	...	...	...	...
1859	46·3	58	33	8·5	52	7·2	2·9	0·7
1860	41·7	58	26	9·2	54	9·6	2·3	0·7

Quarter ending 30th June.

	Temperature: Mean.	Temperature: Highest.	Temperature: Lowest.	Temperature: Daily Range.	Rain: Days.	Rain: Inches.	Humidity: In cubic foot of air. (grs.)	Humidity: Required for Saturation. (grs.)
1851	53·4	75	36	13·6	35	4·4	3·7	1·2
1852	50·2	62	36	6·5	38	10·3	3·1	0·9
1853	52·9	75	36	12·0	41	7·5	3·7	1·1
1854	51·4	72	36	12·7	39	5·1	3·4	1·1
1855	48·8	70	29	13·2	40	5·6	2·8	1·3
1856	50·4	75	38	10·6	35	8·7	...	...
1857	53·1	75	35	9·3	34	7·4	3·5	1·1
1858	53·0	77	34	11·8	33	6·1	3·6	1·2
1859	53·5	72	35	13·5	38	3·8	3·6	1·4
1860	50·0	69	40	...	47	11·0	...	...

Quarter ending 30th September.

	Temperature: Mean.	Temperature: Highest.	Temperature: Lowest.	Temperature: Daily Range.	Rain: Days.	Rain: Inches.	Humidity: In cubic foot of air. (grs.)	Humidity: Required for Saturation. (grs.)
1851	59·8	75	45	12·6	28	5·0	4·4	1·5
1852	60·5	81	46	10·8	39	9·7	4·8	1·3
1853	58·3	75	45	11·0	46	6·5	4·5	1·1
1854	56·7	75	36	11·8	41	8·5	3·5	1·1
1855	59·3	76	44	10·6	33	4·3	4·5	1·3
1856	59·6	79	44	11·3	34	6·0	...	...
1857	61·5	78	47	12·1	27	3·5	4·4	1·6
1858	60·3	78	44	16·6	25	5·8	4·6	1·3
1859	62·1	82	44	10·2	45	6·9	4·7	1·0
1860	55·7	74	42	9·9	50	6·3	4·3	0·8

Quarter ending 31st December.

	Temperature: Mean.	Temperature: Highest.	Temperature: Lowest.	Temperature: Daily Range.	Rain: Days.	Rain: Inches.	Humidity: In cubic foot of air. (grs.)	Humidity: Required for Saturation. (grs.)
1851	47·1	67	32	8·5	32	5·8	3·2	0·7
1852	50·4	62	32	7·7	66	23·0	3·6	0·8
1853	46·3	63	24	7·6	48	11·2	3·2	0·7
1854	46·9	67	30	8·9	38	6·9	3·1	0·8
1855	45·7	63	27	7·2	33	7·2	3·2	0·5
1856	48·2	65	26	7·9	29	7·5	3·1	0·8
1857	51·0	65	34	6·7	43	7·7	4·0	0·5
1858	47·7	68	29	9·3	41	10·6	3·4	0·7
1859	...	65	21	...	46	11·5	...	...
1860	46·0	61	22	7·8	49	12·3	3·3	0·2

COMPARATIVE STATEMENT, FROM THE REPORTS OF THE REGISTRAR-GENERAL.

(1853 TO 1860 INCLUSIVE.)

Torquay ..	42·0	58	18	8·1	38	7·0	2·6	0·6
Clifton	38·7	60	11	10·8	45	6·1	2·5	0·4
Ventnor...	42·3	59	21	8·4	39	5·6	2·6	0·5
Exeter	41·4	61	14	12·2	47	7·0	2·7	0·4
Oxford	39·0	64	19	11·9	36	4·5	2·5	0·3
Greenwich	39·1	64	11	12·2	39	3·8	2·3	0·4

Torquay ..	51·6	77	29	11·8	38	6·7	3·4	1·2
Clifton	51·3	86	24	17·8	40	7·5	3·5	0·9
Ventnor...	50·7	82	32	11·0	34	5·7	3·9	0·8
Exeter	52·8	86	28	17·5	41	6·9	3·4	1·2
Oxford	51·7	90	25	17·6	36	6·8	3·4	1·0
Greenwich	52·1	94	25	20·3	34	5·5	3·5	1·9

Torquay ..	59·9	82	36	11·6	37	5·9	4·3	1·1
Clifton	59·2	91	33	15·1	44	8·8	4·5	1·0
Ventnor...	61·9	82	41	9·9	35	8·0	5·1	0·9
Exeter	60·3	91	38	17·2	47	6·0	4·5	1·4
Oxford	58·9	89	37	16·5	37	8·3	4·5	1·0
Greenwich	60·2	93	34	20·8	37	7·4	4·5	1·3

Torquay ..	47·4	68	21	7·9	41	9·3	3·3	0·6
Clifton	44·0	67	7	10·2	52	6·9	3·0	0·4
Ventnor...	47·5	70	21	7·5	44	8·4	3·5	0·5
Exeter	46·2	70	16	11·6	50	8·4	3·2	0·5
Oxford	43·5	68	16	11·1	44	5·9	2·9	0·4
Greenwich	43·8	72	8	12·0	37	5·5	3·0	0·4

From the preceding Table the following general results may be deduced:—

Mean Summer Temperature, and highest extreme,—

Torquay . 55°·7, 82°.	**Clifton** . . 55°·2, 91°.	Ventnor . 56°·3, 82°.
Exeter . . 56°·5, 91°.	**Oxford** . . 55°·3, 90°.	Greenwich 56°·0, 94°.

Mean Winter Temperature, and lowest extreme,—

Torquay . 44°·7, 18°.	**Clifton** . . 41°·3, 7°.	Ventnor . 44°·9, 21°.
Exeter . . 43°·8, 14°.	**Oxford** . . 41°·2, 16°.	Greenwich 41°·4, 8°.

Mean daily range of Temperature,—

Torquay . . . . 9°·8.	**Clifton** . . . . . 13°·4.	Ventnor . . . . 9°·2.
Exeter . . . . . 14°·6.	**Oxford** . . . . . 14°·2.	Greenwich . . 16°·3.

Annual amount of Rain, in inches, and number of days on which it fell,—

Torquay . 28·9, 154.	**Clifton** . . 29·3, 181.	Ventnor . 27·7, 152.
Exeter . . 27·3, 185.	**Oxford** . . 25·5, 153.	Greenwich 22·2, 147.

Actual and sensible Humidity, or the number of grains of aqueous vapour in a cubic foot of air, and the amount required to produce saturation,—

Torquay . . 3·5, 0·8.	**Clifton** . . . 3·1, 0·6.	Ventnor . . 3·4, 0·6.
Exeter . . . 3·4, 0·8.	**Oxford** . . . 3·4, 0·6.	Greenwich . 3·3, 1·0.

The influence of climate upon health and longevity is very clearly shewn in the recent comparisons drawn by the Registrar-General between the several watering places in England. The following is from the last Quarterly Report:—

Annual rate of mortality to 1000 persons living in the districts containing the following watering places:—

	1851 to 1860	Quarter ending 30 June, 1864		1851 to 1860	Quatr. endg. 30 Jne. 1864
Isle of Wight	17	15	Dover	20	20
Eastbourne	17	17	Malvern	20	20
Torquay, Teignmouth and Dawlish . . .	18	16	Buxton and Matlock .	20	20
			Bangor	20	22
Worthing	18	18	Whitby	20	23
Ilfracombe	18	18	Anglesey	20	24
Weymouth	18	21	Leamington	21	21
Hastings	18	24	Scarborough	21	22
Cheltenham	19	17	Ramsgate and Margate	21	23
Kendal	19	19			
Tenby and Pembroke .	19	19	Clifton	21	24
Aberystwith	19	21	Brighton	22	20
Lowestoff	20	18	Bath	22	25
Tunbridge Wells . . .	20	20	Yarmouth	25	25

"In England," he states in the preceding report, "there died 14,698 persons more than would have died had the temperature and other circumstances been as favourable as usual." "On the night of Thursday, January the 7th, it is computed that 877 lives were extinguished by the cold wave of the atmosphere." In the Metropolis, during the quarter, one funeral in six was due to the cold. The mean temperature during the entire quarter was 37·°9, against 42·°6 in the first quarter of 1863.

The average mortality of England and Wales is far greater than at any of the above watering places, amongst which the Isle of Wight, Eastbourne, and Torquay, with the other towns on this coast, are pre-eminent. The climate in each of these is nearly the same; but at Torquay this extends over a large extent of beautiful country, with the greatest variety of elevation and aspect.

ON THE LATE REV. PROFESSOR HENSLOW'S SYSTEM OF TEACHING BOTANY.

BY W. S. M. D'URBAN.

HAVING undertaken to instruct a class in botany in connection with the Exeter Science Classes, under the auspices of the Science and Art Department, I had to consider upon the best mode of instruction to pursue, and to assist myself in making a selection I consulted Dr. J. D. Hooker, the Assistant Director of the Royal Botanic Gardens at Kew, who is equally well known for his profound knowledge of botany, and the readiness with which he communicates that knowledge to others. The result was, that I determined to adopt the system introduced with such success by the late Rev. Professor Henslow into his village school, at Hitcham, in Suffolk.

This system consists in making the pupils fill up printed forms, like that annexed (No. 2), called floral schedules.

My present purpose is to explain the manner in which I have endeavoured to adapt this system to the requirements of a mixed Class, consisting of persons of widely different ages, so as to enable each pupil to pass the annual local examination, instituted by the Science and Art Department.

I had a quantity of the two annexed forms of schedules printed, one (No. 1) containing the Terminology required for the other, which is left blank, to be filled up by the pupils, to each of whom I distributed copies, and they then either purchased others as required, at the cost of printing, or they ruled waste pieces of paper, like schedule No. 2.

In the first place, I commence by pointing out to my class the advantages of the study of botany, both directly and indirectly, to persons in every rank of life. As an intellectual weapon for the discipline of the mind, in observing and reasoning it cannot be too highly recommended, whilst in many professions it is absolutely indispensable.

I then consider botany as a branch of natural history, explaining the differences between the inorganic and organic worlds, and those between the animal and vegetable king-

doms; demonstrating the most important distinctions between them, and proving that in their lowest forms they approach so closely, if they do not actually unite, that it is impossible to say where animal life ends, and vegetable life begins.

I next treat of botany as a separate science, enumerating its various branches,—systematic, physiological, geographical, economic, and fossil botany.

The main feature by which this system is distinguished is, that each pupil is encouraged, by every possible means, to examine plants for himself, and never to take anything for granted that he is told about them, but to prove everything for himself. At the very outset therefore, living specimens of plants are placed in his hands. This, I am convinced, is the secret of the success of the system; for there are, I think, but few persons absolutely insensible to the beauties of the Creator's handiwork; and if the pupil can only be induced to examine plants closely, an interest in them is soon awakened in his mind, leading him on to the study of the drier portions of the science; which, had they been entered upon without the attractions presented to the eye by natural objects, would only have disgusted and disheartened him. Having once carefully examined a plant and noticed its peculiarities, the pupil is naturally anxious to ascertain the name by which it is known, and by which he can speak of it to others: and he is thus imperceptibly induced to study systematic botany. Moreover, to use the words of Dr. Hooker in a letter to me, "There is no such thing as teaching botany, or any other branch of natural history—all that can be done is to teach students how to acquire it for themselves, and this cannot be better reduced to practice than by examining living specimens, and working the schedules."

I also endeavour to induce my pupils to commence collecting plants at once, and I instruct them in the best and easiest means of doing this; and also how to dry, mount, and arrange their specimens for future reference.

The only botanical works I recommend to my pupils are Lindley's "School Botany," and Bentham's "Handbook of the British Flora." At the end of the last edition of "School Botany" is an excellent chapter, devoted to the art of describing plants, designed for self-instruction. This is published in a separate form, at the price of 1s., and contains diagrams illustrative of the different terms employed in descriptive botany. When economy is an object to the pupil, this little pamphlet is of great assistance to him, as well as to the teacher, the latter being saved the trouble of explaining many

terms of minor importance. All these preliminaries being disposed of, and having demonstrated the necessity of a systematic arrangement of the 100,000 species of plants supposed to be at present known to science, I enter upon the real work of instruction in filling up the floral schedule, by enforcing the principal distinctions between the three great natural classes of plants (dicotyledons, monocotyledons, and acotyledons) upon the attention of the pupils. I then distribute examples illustrative of each class to them, and they write down upon slates the class to which they suppose each belongs, and the reasons which have influenced their decision. The attention of the pupils is also called to the very obvious distinction between flowering and flowerless plants. At first, I confine my attention to the former, the study of the latter being so complicated, as almost to constitute a separate science in itself.

The parts, or organs, of plants are next described; namely, the root, stem, leaf, flower, and fruit, and I demonstrate that the fruit is merely a portion of the flower modified and developed; a flower, an assemblage of modified leaves on a stunted branch; a leaf, an expansion of the outer covering, and a root, an underground prolongation of the inner parts of the stem.

It will be observed, that the greater portion of the floral schedule is devoted to the reception of the terms used to denote the various organs of the flower, and the mode of arrangement, &c., of the parts of which each organ is composed. This is because the flowers of plants afford the most conspicuous characters for their classification, and those most likely to arrest the attention of the beginner. I therefore next point out the distinctions between the four whorls of leaves, of which a perfect and complete flower, such as that of the Flax plant, is composed; namely, the calyx, the corolla, the stamens, and pistil. I cause each pupil to pull a flower to pieces, and to lay the parts composing each organ in corresponding spaces ruled to receive them upon a slate opposite their appropriate names, which are written upon a piece of paper pasted down on the slate. The pupil then counts the pieces in each compartment of the slate, and writes the number in the column ruled on the left hand side of it. By this means the pupil soon understands the plan upon which flowers are constructed, and he perceives that there are certain numbers which prevail in the leaves of the floral whorls in the two classes of flowering plants; namely, four and five and their multiples in dicotyledons, and three

and its multiples in monocotyledons. Having practised a little on the slate, he is competent to fill up the first blank column in the schedule.

The next step to be taken is to explain the "cohesion" or union of the different leaves in each whorl of the flower amongst themselves, and also the manner in which the development of certain of them may have been "arrested," leading sometimes to their complete obliteration. Thus the petals of the corolla may be united together into a tube, and appear to be but one leaf. In this case the pupil would write the word *monopetalous* (that is, with one petal) in the space in the second blank column of the schedule, opposite *co. p.*, or, "corolla petals." Again, the petals may be suppressed or not developed, and then *apetalous* (that is, without petals), would be written in the same place as before.

After this comes the "adhesion" of the leaves of each whorl with those of the other whorls. "Adhesion" is also synonymous with "insertion." For instance, the filaments of the stamens of the common primrose adhere to or are united for nearly their whole length with the corolla, and they therefore appear to be "inserted on the corolla," and are termed "*epipetalous.*"

The classes having been already learnt, the next thing to be acquired by the pupils, when they have got thus far, is how to distinguish the divisions of each class, namely, Angiosperms and Gymnosperms in dicotyledons, Petaloid and Glumaceous in monocotyledons, Acrogens and Thallogens in acotyledons.

Then we proceed to the sections of Angiospermous dicotyledons, namely, Thalamifloræ, Calycifloræ, Corollifloræ, and Incompletæ; and those of Petaloid monocotyledons, namely, Superior and Inferior. Gymnospermous dicotyledons and Glumaceous monocotyledons are not subdivided into sections.

Having now disposed of all that relates to the flower itself, as far as is necessary to fill up the schedule, we enter upon phyllotaxy, or the arrangement of the true leaves upon the stem. Each leaf has its place on the stem assigned to it before it grows, by an unerring and simple mathematical law, which is duly explained.

We also consider the "insertion," or mode of attachment of the leaf to the stem, its composition and stipulation.

Then comes "inflorescence," or the manner in which the stalks supporting the flowers are branched and arranged on the stem. This subject requires a good deal of demonstration, and I show how the various parts and forms of indeterminate

inflorescence pass into each other, and the way in which all forms of indeterminate can be distinguished from determinate inflorescence.

I conclude my instruction as far as relates to the use of the schedules, with an explanation of the artificial system of Linnæus, which, though long gone out of favour, and a thing of the past, is sometimes useful to my pupils; for many of them posses old fashioned works on British botany arranged on this system, and it habituates them to the use of many important botanical terms.

At every lesson, I exhibit specimens of the wild plants then in bloom, in stands constructed for the purpose, with a label in front of each plant, showing its class, division, section, order or natural family, genus, and species, and these are copied by the pupils in filling up the corresponding blanks in their schedules. In this way they gradually acquire the names of most of our common wild plants.

I have also prepared numerous diagrams, and schedules of classification, numeration, &c., and each has been suspended before the class at many successive lectures, so that they are thoroughly fixed in the memories of the pupils; information taken in by the eye being so much more readily retained than that which enters in by the ear; and to prevent anything being forgotten, I also frequently question my pupils on those points in which they have received instruction.

The pupils being thoroughly trained in the use of the floral schedules, and having by that means acquired some knowledge of morphology, as well as of the terms necessary for describing plants; they next exercise themselves upon full-length descriptions, on the model of those given in Lindley's pamphlet.

Being now accustomed to note minute characters, they have little difficulty in discovering the genus and species of any British plant, if they have the use of a work upon the British Flora. Their acquaintance with plants is all this while gradually extending, and to hasten its increase I take each of the principal orders of British plants in succession, dwelling on their prevailing characters and properties, especially those which best distinguish them from allied groups; exhibiting dried or living specimens of the most important British species, alluding to their most interesting foreign relatives, and explaining their uses to man.

The pupils having been brought thus far, I enter more fully into the growth of plants from seeds and buds; their chemical composition, and the formation of the vegetable

fabric. This leads us to the economic products derived from the vegetable kingdom, and which, properly illustrated, cannot fail to prove the £ s. d. value of botany, in addition to its other attractions.

This system of teaching admits of very general application, and can easily be carried out by any person of average ability, with a slight knowledge of botany; and as its success has been proved by others as well as myself, I hope that what I have now said, may lead to its more general adoption.

No. 1.

TERMINOLOGY REQUIRED FOR FLORAL SCHEDULES.

Flower.	Cohesion. Arrest.	Adhesion. (insertion)	Leaf.
pistils / carpels	mono- to poly- -gynous.	superior, or inferior.	Position: radical, cauline. Arrangement: alternate, opposite, verticillate. Insertion: petiolate, sessile. Composition: simple, compound, decompound. Stipulation: stipulate, exstipulate.
stamens filaments anthers	mono- to poly- -androus. di- tetra- dynamous. mono- to poly- -adelphous. syngenesious.	epipetalous. synandrous. Hypogynous. Perigynous. Epigynous.	**Inflorescence.**
corolla petals	mono- to poly- -petalous.		Character: solitary, spike, raceme, panicle, corymb, umbel, head, cyme. Bracteation: bracteate, ebracteate, involucrate.
calyx sepals	mono- to poly- -sepalous.	inferior, or superior.	
perianth leaves	mono- to poly- phyllous.		**Linnæan System.**
Class, Division, Section, and Order, as far as illustrated by the Types selected at Lectures.			Class and Order.

No. 2.

<table>
<tr><th>Fl.</th><th>No.</th><th>Cohesion. Arrest.</th><th>Adhesion.
(Insertion.)</th><td rowspan="3">Leaf.
pos :
arr :
ins :
com :
stip :</td></tr>
<tr><td>pi.
ca.</td><td></td><td></td><td></td></tr>
<tr><td>st.
f.
a.</td><td></td><td></td><td></td></tr>
<tr><td>co. p.</td><td></td><td></td><td></td><td rowspan="2">Inflorescence.
char :
bract :</td></tr>
<tr><td>ca. s.</td><td></td><td></td><td></td></tr>
<tr><td>ph. l.</td><td></td><td></td><td></td><td rowspan="2">Linnæan System.
Class.
Ord :</td></tr>
<tr><td colspan="2">Class.
Div.
Sec.</td><td colspan="2">Or.
Gen.
Sp.</td></tr>
</table>

THE HONEY BEE.

BY S. BEVAN FOX.

As the time at our disposal is necessarily limited, I will presume that the majority of my audience are already acquainted with the various inmates of a hive—the queen, drones, and workers. I had intended, for the benefit of any present who may be unacquainted with the subject, to have given an epitome of the history and physiology of bees, and their increase by natural swarming; but time will not permit, and I therefore at once pass to the consideration of the science of *artificial swarming*.

I need not remind you that the same egg, which, if deposited in an ordinary worker-cell, would become developed into a common worker or neuter bee, will, if deposited or nurtured in a royal cell, and by a different course, both of treatment and of food, become transformed into a creature possessing very different functions. Acting on this knowledge, a queen may be removed from a hive, leaving no royal cell whatever, in course of progress or otherwise. Provided there is comb containing eggs, or very young worker larvæ, the operator need be under little fear of the loss of his stock, always supposing that drones exist in or near his apiary. On discovering the loss of their queen, the bees usually become very excited, rushing over the combs, and in and out at the entrance. Gradually their excitement cools down; some eggs, or young grubs, are selected; the cells adjoining which are torn away, and remodelled into one suitable for a royal larva. A different food is supplied, and in a much shorter time than would have been the case if the worker grub had been allowed to be developed into a neuter, a perfectly-formed princess emerges from one of the cells. Her first object is to effect the destruction of her rivals.

The scientific operator will not wait for the chances and uncertainties attending natural swarming. He sees a way of increasing his stocks to an extent utterly impossible by following the old system. And here it may be best to give you the details of my own practice. The majority of my hives are constructed with moveable frames or bars, by which the

interior can always be examined, and the combs separated to any extent. Every frame or bar fits any hive in the apiary. In describing the necessary manipulations, it must be considered that I am now speaking of hives managed on this principle; but, with some modification to suit various hives, the same system may be successfully carried out. We will imagine a strong colony, which we will call A, from which an increase is desired. On a fine day, each comb is lifted out and examined, in order to discover the whereabouts of the queen. When found, the comb, with her majesty and the bees adhering to it, is placed in an empty box, B, and many of the remaining bees in the stock are brushed or shaken off into it. This new hive B takes the place of A, which is either conveyed to a distant garden at once, or the bees confined, and the hive carried into a cool, dark place for 24 hours. At the end of this time, the old stock (A) may be located in a new position in the same garden. The bees, after the discovery of the loss of their queen, will soon commence the formation of several royal cells, usually fixing on very young grubs for the purpose. In 12 or 14 days a queen arrives at maturity, and on gaining her liberty, immediately endeavours to destroy all her rivals in the other cells. The careful operator may, if he be vigilant, generally prevent this destruction, by a timely removal of the superfluous royal cells; and these may be made available in the formation of other artificial swarms. By the adoption of this system, which is carried out in great perfection by my friend Mr. Woodbury, of Mount Radford, Exeter, a great saving of time and resources, to the hives deprived of queens, is effected, and an astonishing number of swarms may be made. I should have stated, that when the comb with the queen is removed from the stock, the remaining combs should be brought together, as the queenless bees would most probably construct *drone* comb, which would be decidedly injurious, if left in the centre of their habitation. But another plan (which I call the building-up system) has been the most largely adopted in my apiary, and in that of Mr. Woodbury. Several small boxes, capable of containing four frames only, styled *nucleus* boxes, are provided. As before, the cover of the stock-hive is taken off (a little smoke may be puffed in under the cover previously, if liked); a side comb is first extracted, and examined to see that the queen is not on it. This is put down by itself. The next comb is taken out, examined, and, if not containing brood of a suitable age, is slipped down into the place previously occupied by the first comb removed. When a comb suitable in

every respect is found, vigilant search must be made to ascertain if the queen is on it. If not to be seen, it is necessary to look through the stock until her majesty be found, so as to be certain that she is not on the comb which is selected. A few hundreds of bees, chiefly very young ones, that have not yet taken their first flight abroad, are brushed off some of the combs into the nucleus into which the brood-comb has been placed. Two frames, containing empty combs, are added; the nucleus box is shut up, and taken within doors until the evening. Proper ventilation must, of course, be afforded. It is best to liberate the prisoners towards evening of the following day, when royal cells will usually have been commenced. The nucleus may stand in any position in the apiary. An empty frame must be given to the old stock, either taking the place of the comb removed, or occupying the side, the other combs being pushed up together.

The nucleus should be examined in a few days, for the double purpose of ascertaining whether royal cells have been constructed, and also if there be a sufficient population. If the bees are very few in number, the same stock hive may be visited, and a brood comb picked out, which, with the bees clustering upon it, after it has been ascertained that the queen is not among them, is added to the nucleus, and placed in juxtaposition to the brood comb previously given. Or, instead of inserting the brood comb, the bees may be brushed or shaken off from it on the tops of the frames, and the whole confined for a few hours. When the royal cells are sealed, if there should be more than two constructed, the surplus may be carefully cut out, and a fresh nucleus formed. To effect this a comb, containing brood in an *advanced* stage, is selected; an aperture, corresponding in size to the piece of comb to which is attached the royal cell or cells, is cut out, and the latter carefully inserted, using the utmost caution not in any way to bruise or injure the cells containing the royal embryos. Bees must be obtained as before. It will be obvious that a great saving of time is thus effected, as the queens in the two nuclei will issue forth nearly at the same date. These small swarms, as soon as the queens begin egg-laying, may be shifted into boxes containing seven, eight, or more frames, and again strengthened with brood combs from any hive in the apiary. If possible, a frame containing an empty worker comb should always be slipped into the space from which the other was taken. The old queen will usually, in a very few days, have filled the empty comb with eggs: thus are her enormous powers of fecundity encouraged and stimulated to the utmost.

I have found this mode of procedure, that is, of raising queens in nuclei, and gradually building up the diminutive swarms into populous stocks, very successful, and by no means difficult of accomplishment with hives suitable for the purpose. There are several other ways of effecting the same object, but I have said enough to explain the *rationale* of the system. I have yet to show how artificial swarming may be effected with the old-fashioned hives. I will quote the substance of some remarks in a paper written by me on this subject, which appeared in the *Journal of Horticulture*, on the 10th of May of this year:—"We will suppose it is desired to operate on three stocks, A, B, and C. If possible, commence ten days before it is intended to form an artificial swarm, by raising in a nucleus box a few royal cells, which should, by the time they are required, be properly sealed over." (This is done in the manner I have before explained to you.) "Choose a fine day, when the bees are out working well. Drive every bee out of A, first placing an empty decoy hive on its stand, to amuse the returning foragers. Put the new swarm in the old position, adding to it the bees collected in the decoy hive. Then take one or two of the royal cells, and carefully fix among the combs of the old stock, either by cutting out a small piece in the vicinity of the brood, or in any way that may seem best to the operator. Having done this, remove populous hive C to another part of the garden, and place the driven stock A, containing quantities of brood and the added royal cells, in C's position. The bees returning home will, after hovering about a little, settle quietly in A, and, with the hatching out of the brood, will soon make it very populous. In about ten days, drive B in the same manner. Insert royal cells, or add the young queen, now, most probably, at large in the nucleus, and stand B in the place of A, which must be a second time removed. Soon after this, C (the first hive transposed to afford bees for A,) will have become full of bees. This, then, may be driven, and stood in B's place. Thus far the hives are exactly doubled in number. If more are required, the changes can be rung in the same manner; but this would satisfy any apiarian who desired his colonies to be in the best working condition. It is by no means necessary that royal cells be given to the driven stocks, but it saves a very considerable amount of time at the most important period of the season." (I adopted the foregoing system to a large extent in 1861.) "Having doubled my straw stocks, they speedily became so populous, that I was enabled to drive them a second time."

That the culture of bees on scientific principles, and more particularly the application of the principles of artificial swarming to their multiplication, is worthy of more consideration than is usually conceded to it, I am thoroughly convinced. Dzierzon, a German apiarian of the highest excellence, owing to a destructive malady (foul brood) which attacked his apiary, was reduced from 500 stocks to about 10; yet, by the artificial multiplication of these ten hives and their progeny, in the short space of three years he had increased them to 400. Contrast this with the very small number he would have had in the same period of time, if he had trusted to natural swarming alone. I trust I have said enough to convince any apiarian who may happen to be present, that, unless he has arrived at the requisite knowledge, and the ability to perform the necessary manipulations, he has yet much to learn both as to interest in, and success in the management of, these useful little creatures. It has therefore appeared to me, that the subject of this paper is a very fit one for consideration in a meeting of the Society for the Advancement of Science and Art.

Parthenogenesis.—Perhaps there is no discovery connected with bees which has created more difference of opinion than that of parthenogenesis, as connected with the reproduction of bees. I should hesitate about alluding to this in any ordinary lecture; but, as the objects of this society are especially directed to the elucidation of newly-discovered and mysterious truths, I do not think it would be right to pass by this important question. To Dzierzon, the great German apiarian, and to Von Siebold, professor of zoology and comparative anatomy in the University of Munich, we are chiefly indebted for this discovery. After the most minute and careful investigation, he has proved, beyond doubt, that both the queen and certain of the common bees possess the power of laying eggs, without having previously been fecundated by the male or drone bee.

Huber believed himself to be the discoverer of a strange truth. He asserted that, if a queen failed in meeting with impregnation before the 20th day of her existence, she is never capable of laying the eggs of workers, and will produce those only of drones. He gives an instance of retarded impregnation, which I will repeat in his own words:—"The moment one" (a queen) "was hatched, I confined her to the hive by contracting the entrances. When assailed by the imperious desire of union with the males, I could not doubt that she would make great exertions to escape, and

that the impossibility of accomplishing it would produce a kind of delirium. We had the patience to observe this queen 36 days. Every morning about eleven o'clock, when the weather was fine, and the sunshine invited the males to leave the hives, we saw her impetuously traverse every corner of her habitation, seeking to escape. As she was never out during this time, she could not be impregnated. At length, on the 36th day, I set her at liberty. She soon took advantage of it, and was not long before returning with the most evident marks of fecundation. Satisfied with the particular object of the experiment, I was far from any hopes that it would lead to the knowledge of another very remarkable fact. How great was my astonishment, therefore, on finding that this female, which, as usual, began to lay 46 hours after being fructified, produced the eggs of drones, but none of workers, and that she continued ever after to produce those of drones only."

He elsewhere asks, "Why does the delay of impregnation render queens incapable of laying the eggs of workers? This is a problem on which analogy throws no light, nor in all physiology, am I acquainted with any fact that bears the smallest similarity. The problem becomes more difficult by reflecting on the natural state of things; that is, when fecundation has not been postponed. The queen then lays the eggs of workers 46 hours after her union, and continues for the subsequent eleven months to produce these alone; and it is only after this period that a considerable and uninterrupted laying of the eggs of drones commences. When, on the contrary, impregnation is retarded after the 20th day, the queen begins, from the 46th hour, to lay the eggs of males, and produces no other kind during her whole life."

It is evident that Huber here stopped short of the truth. Astounding as the supposed discovery appeared to him, how much more surprised would he have been, if he could have been told that queens, which have never been fecundated by the male at all, have the power of laying drone eggs, which will develop into perfect insects. It has long been known that there are, occasionally, in a hive, certain workers which have the power of laying drone eggs. These were supposed, by Huber and others, to have been fecundated by drones; but it is proved, beyond all doubt, that such union is impossible. Here, then, is a convincing proof of the correctness of parthenogenesis as applied to the honey bee.

Huber believed, that in the oviducts of the queen bee, first came the eggs of workers only, and then a layer of those of

drones; and that it was impossible for her to deposit the eggs of drones until all these worker eggs should be disposed of. It is evident that he was much mistaken in this idea. The eggs which will become drones and workers are precisely the same. I have frequently had young queens which, during the first few weeks of their existence, have laid the eggs both of workers and of drones. There is no difference whatever in the eggs of drones and of workers; for, as Dzierzon expresses it, "All eggs which come to maturity in the two ovaries of a queen bee are only of one and the same kind, which, when they are laid without fertilization by the queen bee, produce drones, or male bees; but, when fertilized by her, produce female bees, or workers:" and, moreover, "that she has the power of laying eggs which will produce either, at pleasure."

It is impossible, in the space of time allowed me, to say much in order to prove the correctness of these assertions. The Baron von Berlepsch, another eminent German apiarian, has done much to establish the truth of this theory. In May, 1854, he captured an old fertile queen, and in so doing, pinched her so strongly at the apex of the abdomen, that she contracted the whole abdomen, as if stung, and dragged it after her. She laid, however, as before, thousands of eggs, but from all these, nothing but drones were henceforward developed. Her spermatheca was injured, and the muscles which act in the distribution of the fertilizing fluid undoubtedly rendered inoperative. At another time he shut up three queen bees in an ice cellar for 36 hours. All were completely benumbed—only one recovered: she laid, as before, thousands of eggs, but from all of them only males were evolved.

To establish the truth of this theory beyond all doubt, Von Siebold paid a visit to Von Berlepsch at Seebach, and made a most careful microscopic examination of a number of eggs, which had been deposited in cells not more than one hour previously. These eggs were successively subjected to microscopic observation. In some, no particular movement was to be observed, but in others, *motionless* seminal filaments were apparent; and in some, *active* seminal filaments, some of which performed very lively tortuous movements, were distinctly visible. These observations of the eggs of bees are amongst the most difficult of all investigations of the kind. Out of 52 female eggs examined with the greatest care and conscientiousness, 30 furnished a positive result; that is, in 30 he could prove the existence of seminal filaments, in which movements could even be detected in three eggs. Of the other 22, 12 were unsuccessful in their preparation.

Von Siebold next proceeded to examine 27 drone or male eggs with the same care and method with which he had treated the female eggs. He did not find *one* seminal filament in any single egg, either externally or internally. It will be evident, therefore, that he had good grounds for believing that he had established his theory of the doctrine of Parthenogenesis in the bee.

But how is the fact to be explained of the existence in some hives of fertile workers? These workers lay only the eggs of drones, and usually in worker cells. These come to perfection, and are supposed to be adapted for all the purposes of drones generally. It is almost impossible to distinguish these workers from the ordinary community, though Huber succeeded in doing so, and in capturing some in the act of laying eggs. There is now little doubt that the cause of the existence of these fertile workers is, that when a queen is lost or removed from a hive, certain cells in the middle of, or contiguous to, the brood are torn down, and out of these royal cells are constructed. The larvæ in these royal cells are fed with a very different food, and some of this food becomes, by accident or otherwise, supplied to the adjoining worker larvæ. In consequence of this, their reproductive organs are developed to a certain extent, but without any power of sexual intercourse with the drone.

Workers are proved to be imperfect females. We may, therefore, easily imagine that the same food which is so effectual in transforming a worker larva into a perfectly developed queen, may have, to a *limited* extent, a similar effect when supplied to a conmon grub brought up in its proper cell.

Huber and his assistant watched a hive from which the queen had been removed, and in which they had detected the presence of egg-laying workers, with the hope of capturing one of them, and, as he says, "At length, on the 8th of September, we had the good fortune to succeed. A bee appeared in the position of a female laying. Before having time to leave the cell, we suddenly opened the hive and seized it. This insect presented all the external characteristics of common bees, the only difference we could recognize, and that a very slight one, consisted in the abdomen seeming less and more slender than that of workers. On dissection, the ovaries were found to be double, like those of queens, but more fragile, smaller, and possessed of fewer oviducts. The filaments containing the eggs were extremely fine, and exhibited swellings at equal distances. We counted eleven eggs

of sensible size, some of which appeared to have come to maturity." "Fertile workers never lay the eggs of common bees; they produce none but those of males." This has always appeared a most puzzling fact to apiarians, and would probably for ever have remained a mystery, had not *Parthenogenesis* in the honey bee been discovered by Dzierzon and Von Siebold, and accepted as undoubted by the majority of scientific apiarians. What has hitherto been involved in a sea of difficulty, now stands forth as an additional argument in support of the correctness of that theory.

Ligurian Bees.—I must now draw your attention to the Ligurian bee, which was first successfully introduced into this country by my friend Mr. Woodbury, of Exeter, from a Mr. Hermann. It has long been known that a bee, varying in colour considerably from the ordinary brown bee of Europe, existed in the north of Italy and in some parts of Switzerland; but it is only within a few years that the attention of German and English apiarians has been directed to their superiority, both as regards beauty of appearance and in productiveness. In the year 1859, Mr. Hermann having, through the medium of the *Cottage Gardener*, exalted the capabilities of these bees, and signified his desire to transmit them to England, Mr. Woodbury at once availed himself of the opportunity, and succeeded in establishing a yellow queen at the head of a stock of common bees, from which the queen had been removed. This Ligurian queen, with about a hundred of her subjects, was forwarded by post, and was about twelve days in performing the journey. Immediately on the receipt of this first one, I joined with Mr. Woodbury in ordering some more; but this venture was unsuccessful. I tried again a second time, and a queen arrived living, but was too much exhausted to recover. Mr. Woodbury, however, was more fortunate, and by the spring of 1860 had four queens at the head of as many colonies of English bees.

In the spring of 1861 he had nine stocks of Ligurian, and one of common bees. These, aided by one purchased swarm, he multiplied, by carrying out the plan of artificial swarming, in one season, to the following extraordinary extent:—Ligurian queen bees, despatched to various parts of the kingdom, 10; Ligurian stock, sent to a distance, 16; Ligurian stocks and swarms remaining in his apiary, 26; making a total of 52.

From his strongest Ligurian stock he raised *eight* artificial swarms in the spring. In June a large super was put on this hive, which the bees filled with 38 lbs. of the finest honeycomb. After the removal of the latter, another large artificial

swarm was made. There is no doubt in my mind of the superiority of the Ligurians in every respect. By the kindness of Mr. Woodbury, I have been enabled to, more or less, Ligurianise my apiary, and I generally find them superior, both as honey gatherers and in prolific breeding, to any of the stocks of common bees in my possession.

The Ligurian bee is known among naturalists as the *Apis Ligustica*, in contradistinction to the *Apis Mellifica* of Europe and America. The Egyptian bee is, probably, the true type of this bee, which is also found in the Grecian Archipelago. "In its physical characters the Ligurian bee nearly resembles our own hive bee. The difference consists in the first rings of the abdomen (except at their posterior edge), and the base of the third being of a pale reddish colour, instead of a deep brown."

The Germans (to use Mr. Woodbury's own words, in an article written for the Bath and West of England Agricultural Society's Journal), "have devoted themselves most assiduously to the cultivation and propagation of the newly-introduced species, which they have pronounced in every way worthy of the encomiums bestowed upon it. They enumerate the following particulars, in which the Italian is superior to the ordinary honey bee:—1. The Italian bees are less sensitive to cold than the common kind. 2. Their queens are more prolific. 3. Their colonies swarm earlier, and more frequently. 4. They are less apt to sting. 5. They are more industrious. 6. They are more disposed to rob than common bees, and more courageous and active in self-defence. To which I may add, that the brightness of their colours renders them much more beautiful than the ordinary species."

I do not consider the Ligurian bee to be a distinct species. Probably our bee is merely a variety of the same. There is a great tendency, when both varieties are kept within a short distance of each other, for the queens to pair with drones of the opposite colour. Hence it is difficult to keep the Ligurians perfectly pure. But I have proved that the hybridised Ligurian stocks are almost equally prolific and productive as the pure. There is this peculiarity in the bees bred in such stocks: a large proportion of the bees will be distinctly marked as Ligurians, some of which are equal in every respect to the best bred yellow bees; while a greater or lesser number of the progeny of the same mother are in no way to be distinguished from the common brown bee. Contrary to what is asserted of the Ligurians, I believe the bees bred by hybridised queens are really more vicious, if disturbed, than

the common sort. With this exception, I accord to them the same character for superiority.

Foul Brood.—It is generally believed that bees are not subject to any serious disease, with the exception of dysentery. But within the last two years, a disease has attacked certain apiaries with such virulence, as to excite considerable interest among apiarians, and, I may say, considerable anxiety also.

Foul brood, or abortive brood, is a most virulent disease, and may soon be spread to every hive in an apiary from one infected colony. A certain portion of the brood dies in the cells, and, becoming a putrid mass, is not removed by the bees. The queen continues laying eggs all round it, and these, as they approach more or less to maturity, are also infected. So it spreads through the hive. The queen's efforts are relaxed, and the bees themselves become listless and inactive, until the entire colony succumbs. But the mischief does not stop here. Robbers attack the weakened, dying colony, and, in the honey pilfered from the diseased stock, carry the seeds of mortality into other stocks in the same or neighbouring apiaries, which, in the course of time, are also destroyed.

Early in 1863, Mr. Woodbury was aware of some cause which affected the prosperity of his entire apiary. It was some time before he could attribute to it its real character. His hives appeared filled with sealed brood, but the population did not increase in corresponding ratio, and, in fact, became more and more diminished. At length his eyes were opened to the true nature of the calamity, and he at once set about adopting the most vigorous means for its eradication. These consisted in dislodging the bees from the infected hives, and in destroying every comb, taking care that the bees could gain no access to them in any way. The bees were placed in clean hives. When they had made a few combs, they were again dislodged, and these combs destroyed, so that there might remain no trace of the honey removed by them from the original stocks. The bees—again housed in a clean domicile—were now allowed to make new combs for themselves. Even after all this care, the disease made its appearance in some stocks. On observing the smallest recurrence, the hives were again changed, and the combs destroyed. The infected boxes and hives were thoroughly washed out, and cleansed with chloride of lime, and other precautions adopted. By persevering in these violent remedies, Mr. Woodbury has had the satisfaction of completely annihilating the scourge, and his apiary has to a great extent regained its previous prosperous condition.

He published the details of his experience, and the remedies he used to effect a cure, in the pages of the *Journal of Horticulture*, since which many others have had to report the disease as having broken out in their apiaries. Attention having been thus drawn to its existence, we can account for previous complaints of the hitherto unaccountable dwindling away of many a prosperous apiary. Hives mysteriously perished, leaving ample stores of honey and pollen, and with combs sealed over, as if filled with brood; but, doubtless, if a careful examination had been made, the brood would have been found abortive. The disease now known to us as *foul brood* has been long known to the German apiarians. Schirach—a most distinguished observer who wrote in 1770—has a very correct description of it in his book. He says, Foul brood (rendered by his French translator as *faux couvain*) is exceedingly dangerous: it is one of the most fatal maladies to bees—a true pest when the disease has attained a certain stage. I am again quoting from Mr. Woodbury's papers on the subject.

Dzierzon, a country clergyman in Upper Silesia, probably the first apiarian in the world, commenced bee-keeping in the common way with twelve colonies in 1835; and after various mishaps, which taught him the defects of the common hives, and the old mode of management, his stock was so reduced that, in 1838, he had virtually to begin anew. At this period he contrived his improved hive in its ruder form (from which our much improved frame-hive has arisen). This principle gave him command over all the combs.

Though he met with various disasters—70 colonies having been stolen from him, 60 destroyed by fire, and 24 by a flood—yet, in 1846, his stock had increased to 360 colonies, and he realized from them that year 6,000 lbs. of honey, besides some hundredweights of wax. At the same time most of the bee cultivators in his vicinity, who pursued the common method, had fewer hives than they had when he commenced. In the year 1848, this fatal pestilence—foul brood—prevailed among his bees, and destroyed nearly all his hives before it could be subdued, only about ten having escaped the malady, which attacked alike the old stocks and his artificial swarms. He estimated his entire loss that year at over 500 colonies. Nevertheless, he succeeded so well in multiplying, by artificial swarms, the few that remained healthy, that, in the fall of 1851, his stock consisted of nearly 400 colonies. Mr. Quinby, one of the most celebrated of the American bee-keepers, had his apiary ravaged by this disease to such an extent, that in one year 100 colonies succumbed

to its assaults. If such is the virulent nature of the disease, what are the remedies? These require such an amount of courage, patience, and perseverance on the part of the operator, that I am almost inclined to say, Destroy the bees, burn the hives and combs, and everything belonging thereto, and begin again with a fresh stock in new hives. But to those who are willing to devote much time and attention to the object, perhaps it may be as well to quote the plan adopted by some of the first German apiarians. "The bees and queen of an infected colony, having been driven from their own domicile, must be placed in an intermediate hive for four days, during the whole of which period the queen must be kept imprisoned in a queen cage. All the combs made in this hive must be destroyed. At the end of this term the bees must again be transferred to a new domicile, in which they are permanently to remain. It is well to keep the queen confined for a day or two, until comb-building has commenced, and upon her release she will proceed to lay eggs, which, if the matter has been properly managed, will probably hatch into healthy brood. All honey from an infected hive should be kept out of the reach of bees; the combs melted down; the hive itself burnt, if a straw one—carefully scraped, if of wood, and washed over with a saturated solution of chloride of lime, which, in its turn, may be washed off in a day or two with clean water."

This, then, will give some idea of the sensation which was caused among English apiarians, when it was discovered that foul brood, a disease supposed to be known only among foreign apiaries, had really broken out with so much virulence in those of some of our most practical and scientific bee keepers in this country. I have not time now to notice the discussion which has taken place on the subject. Various theories have been promulgated, the majority of which have not even plausibility to recommend them; others, more worthy of notice, have been tried in the balance, and found wanting.

Mr. Woodbury, after having nearly lost his entire apiary, has succeeded in completely banishing the disease, by adopting the severe measures I have recounted.

I must now draw your attention to these sheets of thin wax, impressed with the bases of worker cells, an invention of the German apiarians, to facilitate the labours of the bees, and to induce them to work combs of great regularity. (These were exhibited; also a sheet of the German artificial comb attached to a bar, which had been partially worked, and filled with both honey and pollen; together with the metal plates or dies for impressing the waxen sheets).

ON THE AMOUNT AND DISTRIBUTION OF SUNSHINE,

From Observations made at Exeter and Highwick during thirty-five years.

BY T. F. BARHAM, M.B.

DIRECT observations on the amount and distribution of sunshine have not often I think been deemed worthy of a place in meteorological statistics. For this neglect it seems difficult to account, since no other atmospheric phenomenon is more easily ascertained, more interesting to contemplate, or more important in its economic bearings. Contributing so much as the sunshine does to pleasure, to health, and to all agricultural results, and yet presenting so much variety in the measure in which different districts and seasons are favoured with it, some determinate knowledge on these points seems to be an object at once of rational curiosity and of practical utility.

I make these remarks as an apology for offering to the Society the following statements, which are results of a series of observations which I have regularly and carefully made in this south-western peninsula of England, chiefly at Exeter, and partly at Highwick, through the last thirty-five years—a duration which appears sufficient to yield averages on which considerable reliance may be placed. My method has been simply to take an observation twice every day; that is, at about 9 a.m. and 2 p.m., resulting in a record of one or other of the three following facts, as existing at the moment of observation; namely, either that the sun was then shining in a *clear or open sky*, or that, though visible, he was shining only through a *veil of cloud*, more or less dense; or, finally, that he was *totally hidden* by clouds. It is evident that one or other of these three cases could not but always occur. I recorded them under the heads of *shine*, *gleam*, or *cloud* respectively.

Possibly, it may be thought, that the *second* of these three conditions, that of *veiled sunshine*, or *gleam*, is less necessary to be noticed. But the fact is, that without this distinction

no observations on the sunshine can be made at all definite or complete. The condition of *gleam* occurs almost as frequently as that of open sunshine, and it varies between that and the absolutely clouded in every possible degree. Unless, therefore, there be a distinct place in the record allotted to it, there would be left a large debateable ground, in which the observer would have to decide under which of the two other divisions the case ought to be registered—a task in which he would find no satisfactory criterion to guide him. The middle term, *gleam*, is no doubt somewhat vague, but it serves to give absolute precision to the two others.

It must, however, be confessed, that in dealing with these veiled cases, the observer will find it necessary to take some pains in order to be strictly accurate. To distinguish them from the *clouded*, he must insist on the appearance of some portion at least of the sun's *actual disc*, with a sharp and clear outline; otherwise, he may satisfy himself with a bright luminosity, penetrating or reflected from the cloud, revealing indeed the position of the orb of day, but no part of his true face. On the other hand, to distinguish these cases from *clear sunshine*, he must note whether there be the *slightest visible veil of cloud, fog*, or *mist;* not, however, including in these a mere *haziness*, diffused generally throughout the atmosphere.

With these precautions, the observation of the sunshine is not only simple and easy, but, I think, very reliable; and I hope it will not be imputed to it as a fault, that it requires *no instrument*. Some, however, may fancy that it must be of an uncertain and fortuitous character; but not, I think, with reason For though when made only through a short period, as a single month or year, it might suffer a damaging influence from the caprices of chance, it is evident that when continued through a long series of years, all anomalies from that source will balance one another, and fair averages will be obtained.

And I may here remark, that such direct observation on the sunshine appears able to attain, beyond its own proper results, every end that can be gained for meteorological purposes, by attempts to measure the comparative areas of clear and clouded sky. For while it ascertains, in a direct and certain manner, that which it must be the chief practical object of that other method to ascertain—though it can only do so indirectly and less perfectly—that is, the amount of sunshine, it also affords a fair and sufficient criterion of the degree of clearness of the sky from clouds, which bears to the

sunshine the relation of cause to effect. And this it does with one decided advantage, that it distinguishes between those clouds which are of sufficient density to hide the sun, and those that are not so. It will indicate indeed, as the other method also would, that, on an average, cloud covers in this climate about three-quarters of the sky; but at the same time it informs us, which the other would not, that in one of these three quarters the sun will be visible and shining. For in effect the sun might be visible and shining through the whole course of a day which observation on clouds alone would report entirely cloudy.

Having said thus much in favour of that form of observation, the result of which I have the honour of presenting, I proceed to state, that this paper will exhibit tables of the amount of sunshine as observed by me at Exeter during twenty-one years, from 1829 to 1849 inclusive, and at Highwick for fourteen years, from 1850 to 1863 inclusive. They furnish under the heads of *shine*, *gleam*, and *clouded*, in the senses above explained, monthly and yearly averages, as deduced from my register of daily observations during those periods. Only I must confess, what all who are accustomed to make private observations of this sort will understand, that from absence, illness, and other causes, certain gaps occur in the original series. I am, however, able to state, that the amount of these was not very formidable, not exceeding one-eighth of the whole; and that this defect has been eliminated from the tables, by a careful correction to the full numbers, in due proportion.

For the results in detail, I must of course refer to the tables themselves. But before concluding these remarks, I will take the liberty of noticing a few of the leading facts, taking chiefly for a basis the longer series of observations made at Exeter.

We find, then, taking the year as a whole, that the entries of sunshine, taking shine and gleam together, approach to equality with those of clouded, though slightly *in excess* of them, the ratio being about that of 37 to 35. On an average, then, 37 hours of sunshine to 35 of cloud is the expression for the complexion of our year.

Then, as to the proportion of the two forms of sunshine, the open and the veiled, to each other, this also exhibits a ratio approaching equality, though not so closely. *Shine* is to *gleam* about as 20 to 16; on an average, therefore, *twenty* hours of *open sunshine* are intermingled with *seventeen of veiled.*

Such are the *annual averages* as observed at Exeter. Those obtained at Highwick in the main correspond with them, but with this difference, that whereas at Exeter the balance was in favour of the *sun*, in Highwick it inclines slightly to the other side. The annual average stands thus:—S. 180; G. 182; S. and G. 362; C. 369;—a result which we can hardly err in ascribing to the greater proximity both of the sea and of Dartmoor.

We may also notice a few particulars in the distribution of the sunshine over the several *months*. Inspection of the tables will show, that both at Exeter and Highwick the united sunshine prevails over the clouded during the *six months* from *April* to *September* inclusive; and that, on the contrary, the cloud prevails over the sunshine through the other six months, that is, from *October* to *March* inclusive. The sunniest month appears to be *May*, closely rivalled by *July* and *August;* in all of which the sunshine about *doubles* the cloud. The cloudiest months are *January* at Exeter, *December* at Highwick; but, with small difference, the cloud in both nearly doubling the sunshine. The progress and recession towards these culminating points appears to be pretty regular from month to month, with exception of *June*, which is cloudier than either of the months which lie next to it, as we know it is also rainier—a consequence ascribable to the prevalence of south-westerly wind.

Our observations, therefore, establish statistically what corresponds, for the most part, with popular impression, that sunshine belongs prevailingly to the summer season, and cloudiness to the winter.

I also present a table of the total *annual* results for each of the 35 years to which our observations extend. This will afford the means of judging how nearly the several particular years correspond with the average; in other words of the *range*. It will be seen that, with few exceptions, the extremes of this, both for sun and cloud, lie between 300 and 400; but that, on the whole, there is considerable constancy.

It may further be noticed, that there seems to be a tendency for the bright years to follow each other in *groups* of three, four, or more; and the same of the cloudy, as if from certain atmospheric constitutions prevailing through several successive seasons. Thus the seven years from 1830 to 1836 were remarkable for their sunniness, as the three from 1860 to 1862 were for their cloudiness.

I have also thought it worth while to gather, from these observations, some knowledge of the connection which exists

between the amount of sunshine and the quarter from which the *wind* blew; and I present a table which exhibits this. The general result is, that, on an average, when the wind blows from the N.E. quarter of the horizon, the sunshine exceeds the cloud about in the proportion of 10 to 6; when from the N.W., in that of 10 to 7; when from the S.E., in that of 10 to 9; but that when it blows from the S.W., the cloud predominates, as 10 to 6. The N.E. therefore, notwithstanding his occasional black looks, appears, on the whole, to be the sunniest of the winds, and the S.W., in about an equal degree, the cloudiest.

In concluding these remarks, I can only apologize to the Association for not having it in my power to present anything more worthy of their attention.

Table of monthly and yearly averages of Sunshine, from observations made at Exeter twice a day for 21 years, from 1829 to 1849 inclusive, by T. F. Barham :—

	Shine.	Gleam.	Clouded.	Shine & Gleam
January	12	9	41	1
February	12	10	34	22
March	18	12	32	30
April	20	16	24	36
May	25	17	20	42
June	20	17	23	37
July	21	19	22	40
August	20	19	23	39
September	20	15	25	35
October	16	14	32	30
November	12	10	38	22
December	13	9	40	22
YEARLY AVERAGE.				
	208	167	356	374

Similar Table, from observations at Highwick, near Newton, for 14 years, from 1850 to 1863 inclusive:—

	Shine.	Gleam.	Clouded.	Shine & Gleam
January	12	12	38	24
February	13	12	31	25
March............	17	12	33	29
April	16	17	27	33
May	17	20	25	37
June	15	18	27	33
July	17	20	25	37
August	18	18	26	36
September	19	17	24	36
October	12	15	35	27
November	13	12	35	25
December	11	11	40	22
YEARLY AVERAGE.				
	180	182	369	362

Table of yearly amounts of Sunshine, from observations at Exeter for 21 years, corrected to full proportional numbers:—

	Shine.	Gleam.	Clouded.	Shine & Gleam.
1829.........	198	160	375	355
1830.........	203	196	330	399
1831.........	221	170	329	391
1832.........	255	147	330	402
1833.........	235	163	332	398
1834.........	251	143	336	394
1835.........	270	140	320	410
1836.........	239	157	334	395
1837.........	218	128	384	346
1838.........	186	146	398	322
1839.........	172	169	388	342
1840.........	225	177	330	402
1841.........	192	181	357	373
1842.........	221	187	322	408
1843.........	183	172	375	355
1844.........	229	187	322	410
1845.........	188	197	350	380
1846.........	195	150	385	345
1847.........	181	183	366	364
1848.........	170	176	386	346
1849.........	170	209	351	379

The same for 14 years at Highwick:—

	Shine.	Gleam.	Clouded.	Shine & Gleam.
1850.........	183	196	351	379
1851.........	179	202	349	381
1852.........	189	158	385	347
1853.........	189	173	368	362
1854.........	234	192	304	426
1855.........	149	179	402	328
1856.........	177	175	380	352
1857.........	186	160	384	346
1858.........	177	200	353	377
1859.........	187	196	348	382
1860.........	173	186	373	359
1861.........	164	172	394	336
1862.........	128	179	423	307
1863.........	186	182	362	368

Table showing the proportion of Sunshine with Wind from each quarter, deduced from observations twice a day at Exeter, for 8 years, from 1829 to 1836 inclusive:—

	Shine.	Gleam.	Clouded.	Shine & Gleam.
N.W. ...	86	72	110	158
S.W. ...	27	34	106	61
S.E. ...	54	26	74	81
N.E. ...	64	26	54	90

ON A MODE OF PRESERVING THE IRON PLATING OF WOODEN SHIPS FROM THE CORROSIVE ACTION OF SEA WATER.

BY J. N. HEARDER, ELECTRICIAN, PLYMOUTH.

MASSES of wood, when immersed in sea water in certain localities, are speedily attacked by various marine depredators, such as the *teredo navalis*, &c., which quickly cause serious mischief, by perforating the wood in all directions like a honeycomb,

To obviate this, it is usual to coat ships' bottoms with copper, or one of its alloys, which acts as an effectual, though expensive, preservative against the evil. The action of sea water, however, upon copper produces a corrosion of the surface, which soon becomes covered with a green oxide. In order to prevent this gradual destruction of the metal, Sir Humphrey Davy, many years since, took out a patent for a plan for preserving the copper from the action of sea water, by giving it an artificial electrical condition. This he contrived to do by placing in contact with the copper sheathing plates or bands of cast iron or zinc, the former being less expensive and equally efficacious.

By this means the copper was rendered electro negative; and since the corrosive action in the normal state of the copper depended upon its naturally positive electrical condition in relation to the oxygen of the water, the establishment of a negative electrical state in the copper prevented this union; on the contrary, the iron, in virtue of its contact with the copper, became electro positive, and concentrated the whole of the corrosive action upon itself. The experiment was successful, so far as the preservation of the copper was concerned, but it gave rise to a new evil, which was more disadvantageous than the former one.

The green oxide of copper which formerly covered the surface of the metal was poisonous, consequently no marine creatures would locate themselves upon it; but as soon as

the galvanic protectors prevented this corrosion, and kept the surface of the copper bright, it immediately became covered with whole colonies of living creatures in the form of barnacles, &c., as well as with extensive plantations of *algæ*, which so impeded the passage of the ship through the water as to render the remedy worse than the disease, and the galvanic protectors were consequently abandoned.

Iron is a metal more speedily acted upon by sea water than copper, consequently its destruction is more rapid; and there is this disadvantage; viz., that the oxide of iron not being poisonous, at least to the same extent as copper, *algæ* and marine animals lodge upon the bottoms of iron ships with impunity, involving the necessity of frequent scouring.

If it were simply an object to preserve the iron from corrosion, a modification of Sir Humphrey Davy's plan of galvanic protection would suffice extremely well; but in this case, as in the case of the copper, an increased facility would be afforded for the adhesion of plants and animals.

Science has been taxed to discover a remedy for this two-fold evil, and various compositions, some of them patent, have been applied in the form of varnish or paint. The general efficacy of these mainly depends upon their possessing a poisonous quality, which renders them inimical both to animal and vegetable life.

Some of them profess also to exercise a protective influence over the iron in virtue, not of any electrical quality, but simply in consequence of their impermeability to water. Mr. Todd, of Newcastle, has, however, lately taken out a patent for a metallic varnish, which possesses electrical as well as poisonous qualities; and whilst it prevents organic life of any kind, it also reduces the iron either to a slightly negative or altogether neutral condition, thus rendering it indifferent to the action of oxygen. If this compound be found in practice to be successful, and it is now under trial, it will prove of great value. The conditions, however, to which I wish to draw the attention of the Association, are of a more complex character, having reference to iron-plated wooden ships, in which the copper-sheathing and the iron-plating are both immersed in sea water under circumstances which involve an extremely rapid destruction of the iron. The two metals are, in fact, placed in the same relation to each other and to sea water, as they were under Sir Humphrey Davy's arrangement for preserving the copper at the expense of the iron protector. It has been, consequently, found that the corrosion of the immersed portions of the

iron-plating of wooden ships proceeds at a frightfully rapid rate, when the two metals are in contact with each other; so rapid, indeed, is the action, that a very few months' immersion have sufficed to corrode cavities of an inch in depth, and several inches in length, on the surface of the iron-plates. This is an evil which requires immediate attention, As it is one which might have been predicted as an inevitable consequence of such a state of things, one is at a loss to imagine why it was ever attempted to place the copper-sheathing in contact with the iron-plating, without an effort to introduce some contrivance which should prevent the mischief.

The iron and the copper form together an extensive galvanic pair when immersed in contact in sea water, the iron being positive, and the copper negative, in relation to the fluid, consequently the oxygen of the water is attracted by the iron, and hydrogen is either liberated or otherwise disposed of by the copper. Unless this galvanic action can be prevented, the sacrifice of the iron is a necessary consequence.

Various suggestions have, however, been made, some of which are under trial to meet the difficulty. One plan has been to strip a portion of the copper off the ship's side, leaving a space of two feet of wood surface between the lower margin of the iron and the upper margin of the copper, and this space is covered with sheets of thin iron, first moulded accurately to the shape of the wooden surface to which they are to be applied, and then themselves coated thinly with a vitreous enamel, contact with the copper being prevented by a thin layer of some non-conducting material between the surfaces which overlap each other.

I fear, however, that the proximity of the copper to this glazed iron will give rise to unavoidable, though perhaps small contacts, by which the vitreous iron-sheathing itself will become the conducting link between the copper-sheathing and the armour plates, and the same mischievous results will follow, as if the copper-sheathing had been in actual contact with the plates themselves.

Another plan has been to keep the edge of the copper-sheathing only a few inches from the iron-plating, and cover the intervening wooden surface with a stout zinc plate, which is made to touch each metal, under the impression that the zinc will protect the iron in virtue of its electro positive character, in the same way as the iron protected the copper in Sir Humphrey Davy's arrangement.

Here, then, we have three elements, the iron and copper as

before with an intermediate band of zinc between them, and in contact with both, and all these elements have different electrical relations to each other, and will give rise to a variety of results.

A little reasoning will, I think, shew that some of these will be disadvantageous, whilst it will be a matter of great question if any single advantage will be gained.

First, then, the contact of the zinc with the copper will certainly keep the latter clean, and give rise immediately to a rapid fouling of the ship's bottom, by encouraging animal and vegetable growth, in the same manner as when Sir Humphrey Davy's galvanic protectors were applied, the arrangement being precisely the same.

Secondly, the contact of the zinc with the iron might, if no copper were present, protect the iron from oxidation and keep it clean, since the zinc bears to the iron the same electrical relation that it does to the copper, though in a less degree; but the fact of its connection with the copper imparts to it a second office, viz., that of a conducting link between the copper and the iron; and I think there is every probability that in this capacity it will bring the iron into a higher positive electrical condition in relation to the sea water, than it will be capable of neutralizing by its own action, Should this be the case, the result will be, that the copper will be doubly protected by its high electro-negative condition, whilst the iron and zinc will both be corroded, being both rendered electro-positive.

These were the considerations which prevented me from proposing this plan myself to the Admiralty; for I had frequently thought of it, but was as frequently deterred by the greater probability of failure than success. It has, however, been suggested by some one else, and is now in course of application, and experiment will soon decide the result.

The plan which, after mature consideration, I have been induced to suggest as best calculated to obviate the evil of the corrosion of the iron-plating, without giving rise to any other, is as follows:—

I propose to protect the iron by a band of zinc, placed exclusively upon the iron itself, and having no connection with the copper; and further, in order to prevent any possible influence of the copper upon the iron, or of the zinc upon the copper, I would keep the copper-sheathing some three or four inches away from the iron-plating, protecting the wood surface thus exposed from the ravages of marine animals, by laying on a strip of gutta percha, or one of a dense kind of

vulcanized india rubber, which I think would answer every purpose required.

Neither the gutta percha or india rubber would be injured by the sea water, and its situation would not be one that would expose it to injury. Of course, in this arrangement, it is absolutely necessary that there shall be no other metallic connections of any kind existing between the iron-plating and the copper-sheathing, as these would neutralize the protecting influence of the zinc upon the iron. If any further protection be thought necessary, the exposed surfaces of the iron might be coated with Todd's protecting varnish, which would prevent the accumulation of organic growth, and thus the bottom of the ship, as well as the armour-plating, would not only be preserved, but kept in the best possible condition for nautical purposes.


2
1
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

ON SOME ROMAN-BRITISH REMAINS FOUND NEAR PLYMOUTH.

BY C. SPENCE BATE, F.R.S., ETC.

In the spring of the present year, in order to remove all impediments from interfering with the range of the guns belonging to the new fort erected on Stamford Hill, the engineer found it necessary to cut away the slope between it and the sea. In doing this the excavators came upon sundry evidences of the remains of an antient burial-ground.

The hill on which it stands consists of slate, and is situated between the broad bay of Plymouth Sound on the west and an arm of the sea that is known as Catwater, and flows up the estuary of the river Plym on the east. On the north the land projects to some distance, and ends in a bluff hill of limestone, known as Mount Batten; between which and the hill on which the remains were found is a low grass plane on a gravelly soil, that, previously to the erection of the Plymouth Breakwater, was occasionally flooded at high spring tides. On the east of Fort Stamford, being portions of the same rather than a separate hill, another mass of limestone stands. On the south is the high land of Staddon Heights.

The remains were found in pits, generally about four or four and a half feet deep; one foot of which consisted of soil, the remaining three having been excavated in the partially disintegrated surface of the natural rock. These graves were mere hollow excavations, the walls sometimes sharply cut. This appears to have been the more evident where the soft slaty rock was firmest. The bottoms of the excavations were deepest towards the centre, and they were filled in with the *débris* which had been taken out of them, together with numerous large, rough, worn blocks of limestone, that must have been purposely brought from one of the neighbouring limestone hills.

The removal of the material had been proceeded with for some time, and the workmen state that they had occasionally

found bones and pieces of earthenware. It was only, however, when they found some bronze articles, for which they anticipated getting a few shillings in exchange, that they reported the discovery to Captain Moggridge, the engineer officer in charge of the fortification works. Immediately that the circumstance was known, I was kindly made acquainted with it. Hastening to the place, I watched, as far as practicable, the progress of the exploration.

The graves were very numerous, the longitudinal axis lying mostly in a direction east and west. There were evidences, however, that this was not invariably the case, for in some instances several graves broke into each other, and in one case the extremity (I say the extremity, because this was all that was not dug away when I arrived) appeared to be associated with others, as if it had been made at right angles with them.

When I first arrived, the portions of four graves were exposed in section, out of which had been previously taken some human bones, two bronze armlets, a bronze fibula, and some pottery. After my arrival, some more human bones were found, evidently portions of at least three human bodies, as well as several isolated molars of the pig, several pebbles from the sea beach, mostly of one size, and fragments of glass, together with a vase of coarse ware, in one grave. Upon opening a new grave, we found at the bottom a bronze mirror, in tolerably perfect condition, and some traces of decomposed bones. There was also found in this grave a bronze fibula, by a workman. In other places, the workmen found the handles of two bronze mirrors, two bronze bracelets, of different formations, a bronze dagger or knife in its sheath, portions of a bronze cup, and some fibulæ. There have also been found fragments of many kinds of vases, in more or less perfect pottery ware, portions of the human skeleton, and a considerable quantity of iron, in a very decomposed state, leaving traces of having been parts of implements of some kind.

Bronze Mirrors. (Figs. 1, 2, 3.) The first of these that we found was lying flat at the bottom at the eastern extremity of the grave. It was very nearly circular in form, being, without measurement, imperceptibly longer in one diameter than another, the shortest diameter being probably the vertical axis when in use. The front or polished surface of the mirror was placed downwards. The back, which was upwards, being the best preserved, was ornamented with a considerable quantity of scroll engraving. The pattern consisted of three circular figures, the

two lower ones being larger than that which I take to be the central top one. Although each circular scroll differs from the others, they are evidently figured upon one general plan, the lines within being segments of circles of various sizes, and form crescents with various modifications. Some portions of the engraving, in order to give solidity to the character, were filled in with numerous short striated spots, consisting of three lines in one way, and three lines at right angles. The entire surface of the mirror was surrounded by a narrow border or rim, which was formed of a separate piece, and folded over the margins. This specimen was damaged in many parts, particularly upon the under surface, and some of the edge was entirely eaten away; but where the rim was preserved, the plate was not only in good condition, but not even carbonized, retaining the bright colour of the bronze as perfect as when probably in use by the ancient possessor. With this specimen no handle was found; but a second, (Fig. 2,) of which the very small portion that has been obtained is sufficient to show it to be a duplicate in form, has the handle attached to it. This handle is cast in one piece, in the form of a loop made by folding one half back against the other, and securing them in that position by a band, the two free ends being spread out to hold the mirror, which is received in a groove, and supported on each side by a scroll work of bronze, much of which is lost, but the impression still remains upon the plate. The diameter of the mirror in its greatest length is eight inches; the length of the handle of the duplicate specimen, which is supposed to be of the same size as the missing handle of the more perfect mirror, is four inches.

A second handle (Fig. 3) has also been found of a more finished character. It consists of an oval ring, the longest diameter being at right angles with the vertical axis; a shaft, which is grooved at each end, and doubly so at the middle; at the extremity opposite to the handle is a grooved flange, into which the mirror was secured by rivets. No trace of the plate that belonged to this handle was found; and the difference of form, together with the different style of execution, seen in the detail of some little engraving that is present on the flange of the handle, demonstrates that this mirror must in its complete state have varied considerably from that previously described. The length of this handle is six inches, and the detail of the engraving is made up with small uniform notches, while that of the preceding consisted of short lines, placed by threes, alternately arranged at right angles with each other.

I am informed by Mr. Evans that these mirrors are rare, and that only a single specimen, with engraved back, has previously been found. That was in the county of Bedford, and is now preserved in the museum of the county town. I know not if that is as large as our specimens; but those found generally do not exceed three or four inches.

BRACELETS. (Figs. 4, 5.) The next objects of interest that were obtained from these explorations are a series of bronze bracelets. There were four of one form and one of a second. We will describe the most numerous first. These were formed of solid bronze, flattened upon the internal and rounded upon the external surface. They opened by a hinge in the middle, which was made by the insertion of a tongue with a deep notch or groove, and secured by a rivet, on which the two halves swung. It is not exactly clear what kind of clasp secured them when shut; two of them had one kind, whereas the third evidently differed. From the position of the rivets, it appears that the two fasten by the projection of a central piece of wire, that was caught with a spring clasp, much as we find in the bracelets of the present day. The third has a tongue very similar to that of the hinge, but smaller, and this probably was caught by a spring also. The external surface of these bracelets was ornamented by embossed markings, consisting of a running scroll, that looked like a series of the letter s, folded into each other successively. The rounded portion formed by the bottom of one s enclosing the top of the succeeding is raised and perforated by two deep holes, placed side by side. These holes are in some few places still filled by a dull red bead, as at one time, I have no doubt, were all the rest.

The material of which these beads were formed I am not certain. It may be jasper, as suggested to me by a friend, although, from its appearance under a lense, I am inclined to think that the beads may have been made out of the slag or waste material left in the pots after the melting of the bronze. This is often of a deep red colour. I am informed by Mr. Evans that the insertion of beads in bracelets of this description is rare. The second form of bracelet (Fig. 5), of which we have but two specimens, is much more slender, and almost without ornament. Five embossed bands, of which the middle one is the largest, ornament the middle, which is the stoutest part of the bracelet. This bracelet appears to have had no fastening, and it is evidently formed on the principle of a spring, that yields to the pressure of the hand as it is pressed on the wrist.

Four specimens of fibulæ were found, two in an injured, the rest in a tolerably perfect state. These antique brooches consist of bronze in an arcuate form. The upper end at which the pin is attached has a bar fixed at right angles with the brooch. The lower end is widened into a plate that gradually thins towards the extremity, which is curved to form a secure lodgment for the pin to rest in. The pin in one brooch is attached by being twisted several times round the bar at the upper extremity, and is thus made secure, as well as receives an elastic character, which renders it doubly firm when fixed. In both the others, the cross piece at the top is flattened and turned-up at the extremities, and a bar is fixed between the two extremities. Passing through a hole is a pin, that is rivetted at each end. Round the bar, on each side of the pin, wire is closely twisted; this gives an ornamental finish to the brooch, as well as keeps the pin in its place. The flattened portion, which is bent to receive the pin, is perforated, in one specimen, by three holes, each encircled by a single grooved line.

Small Fibulæ. (Fig. 12.) From one of the latest opened of these graves, we obtained a small bronze brooch, made upon a plan that has recently again come into use. It forms an incomplete ring, the extremeties of which terminate in a small knob. The pin is lost; but it was movable, and made to pass the extremities and impinge with pressure upon the opposite side.

Dirk. (Fig. 6.) A small dirk or knife was also dug out by one of the workmen. The blade of the dirk is still within the sheath; but although the guard is of bronze, yet I am inclined to believe that the blade may be of iron, from the circumstance of there being ferruginous rust both at the entrance, as well as visible through a crack in the side of the sheath. The point that remains of the spill that was inserted into the handle shows that it was of iron also. The form of the knife may probably be suggested from the outline of the sheath. It is four inches long, and about three quarters of an inch broad nearest to the hilt, from whence the sides run parallel to nearly two-thirds the length, when they gradually narrow to the point, one side doing so more rapidly than the other, thus suggesting that one side of the blade possessed a cutting, the other a safe edge. The sheath is formed of two pieces of bronze plate; one has its edges folded, so as to enclose the smaller. A small loop of flattened wire is secured by three rivets to the margin near the handle, which thus enabled the implement to be

secured to a belt. The whole of this, as all the workmanship in bronze, is united by means of rivets, no evidence of solder being apparent in any part of this or other article.

A Bronze Cup. (Fig. 14.) A bronze cup, or rather portions, were found by the workmen. The fragments consisted of the bottom, and a part of the rim. The bottom is about an inch and a quarter across, and the arc of the rim shows the top of the cup to have been about three inches in diameter. The edge of the rim is slightly turned out, a circumstance that is suggestive of a flowing or waved outline to the sides, which were very thin, a fact that accounts for the destruction of the cup.

Glass Bowl. (Fig. 15.) Some fragments of a glass vase or bowl were thrown out of one grave. They are of a beautiful amber colour; the surface being only slightly incrusted with those prismatic hues, that so frequently corrode antient glass that has been long buried in the earth. The fragments that we recovered are the bottom, a portion of the side, and a part of the rim of a basin. The bottom is about two inches and a half across, from which the base passes out in nearly a horizontal line, until it reaches the approximate diameter of five inches; it then gradually ascends to the probable height of four or five inches, and as gradually increases in size until it reaches the diameter of six inches, where it is finished by a shallow rim, formed by the folding of the edge of the glass outwardly back upon its self. The lower portion of the vase is ornamented by a series of raised lines, radiating from the base, but instead of passing directly to the circumference, flow diagonally outward, as if they were formed during the time that the plastic material revolved upon its own axis. Although in many parts the workmanship shows crudeness in execution, yet the vessel, as a whole, must have exhibited an elegance in appearance, that is suggestive of the idea that it must have been the property of an individual of some pretention among his fellows, particularly when we compare it with the quality of the pottery that has been found in the same locality.

Bowl of Black Pottery. With but one single exception, all the ware that has been found in this cemetery is in a fragmentary state. Nor is this to be wholly attributed to the carelessness of the excavators, although no doubt but that in some measure it is due to the fact of the excavations having been carried on by men working for a contractor under Government. They were compelled to pursue their labour assiduously, and were not permitted the time necessary to

remove such fragile material with safety from their positions in the graves. (Fig. 16.)

The ware of this bowl is coarse; it stands upon a circular ring, which is about three inches in diameter. From this bottom the base extends on each side until the diameter is about five inches; the sides then rise inwardly, then gradually curve outwardly, terminating in a small rim at about four inches from the base. There is a small round depression upon the inside, near the upper edge, corresponding with a similar depression upon the outside, from which latter a groove passes as far as the broken edge. This marking is suggestive of a small horizontal handle having been situated in this position; but if so, there was no corresponding handle at the opposite extremity of the basin, since the two fragments together complete more than half the diameter of the vase.

SECOND BLACK BOWL. (Fig. 17.) A second black vase was found by Capt. Moggridge. This is of much finer ware than the previous one, and much more slender in texture; it is also of a much more elegant shape, though formed on the same general design.

The ring at the bottom is about three inches in diameter, the centre of which is deeply excavated, corresponding with a convex elevation on the inside. From the ring at the bottom the sides extend on each side, until the diameter is about seven inches; they then rise slightly inwardly, and then gradually curve outwardly to the edge, where they terminate, without any embossed rim, at a height of about three inches.

THIRD BLACK BOWL. Of a third black bowl or vase, one small fragment only has been recovered; but this is enough to show that the design was the same as the previous. The substance was a little stouter than the last, but less so than the first, and it differed from both in having a double embossed line all round the middle of the sides. This, like the two previous ones, is very dark, almost black, not only on the surface, but through the substance, a circumstance that I think must be due to the character of the clay of which the vessels were made, and not attributable to the muffling of the furnaces during the process of baking.

MINUTE VASE. (Fig. 20.) A very small vase, of a less darkened surface to the two previously discovered specimens, Capt. Moggridge was fortunate enough to save, from the uplifted axe of the excavator, in a perfect state. The bottom is flat, and about an inch and a half in diameter, from which it gradually rises outwardly until just above the middle, from

which point it rounds more suddenly inwards to form a constricted ring just beneath the edge of the mouth, which turns outwards. The diameter at the mouth is about three inches, at the broadest part about three and a half, and the height is about four inches.

RED VASE. (Fig. 19.) The next vase is one that I value, from the circumstance of having figured the entire design from the character of the neck only. I afterwards found part of the sides and the bottom, and was enabled to establish the correctness of my figure. The form of this vase is much like the last described, from which it differs in having a more sudden curving just below the neck; it also stands higher. It is larger, the diameter of the bottom being about four inches, the body of the vessel at its greatest width about seven inches, and the mouth about three. The height is about eight inches and a half.

SCULPTURED BOWL. (Fig. 18.) The next vase to which I wish to draw attention differs in form, and evidently attained a higher degree of external finish. Unfortunately, of this but few fragments have been recovered. It consists of hard-baked clay, of a coarse character. The general colour is red, but in some places the external surface is blackened, probably due to the muffling of the furnace during the process of baking. The height is about four inches and a half; it stands upon a circular bottom of about three inches in diameter, which raises the vessel from the ground about an inch. The bottom of the vase within is flat; the sides gracefully rounded outwards, then inwards, and again outwards to the mouth, the diameter of which is about six inches, being, in fact, the widest part of the vessel, overhanging the body of the vase quite three quarters of an inch. The external surface is ornamented by a rim at the edge, by an embossed ring about an inch below, by a second but less raised ring an inch still lower, beneath which point the swelling part of the vessel is covered by a number of short engraved notches, placed in lines vertical to the base. This latter workmanship resembles the ornamentation of Celtic pottery.

PLAIN WATER JUG. (Fig. 22.) Two vessels, apparently intended for holding water, were found; the first was a plain earthenware bottle, made of very soft friable yellow ware. The body of the vessel was nearly circular, having a flat-ringed base and a narrow neck. This vessel was, when first found, perfect as to form, but intersected by numerous fractures, so that it was impossible to have removed it except

in a very fragmentary condition. It stood in an upright position, and, previous to its removal, I inserted my hand through the broken side, but found nothing within. The height of the bottle, which had a portion of the neck broken off, was about eight inches, and it could not be much less in diameter than six.

Water Jug with Handle. This vessel is of the same general form as the preceding, but somewhat larger. It is of a light yellow friable ware. It probably stood about twelve inches in height, and its diameter, at its greatest circumference, was probably about eight inches. The rim round the mouth was reversed, leaving a hollow between it and the neck of the bottle. The outer surface of the rim is surrounded by a concave ring. From beneath the rim the remains of a handle exist, the opposite extremity of which was, no doubt, attached to the upper portion of the body of the vessel.

Drinking Cup. (Fig. 23.) The only piece of pottery that I have left undescribed of the fragments that we have found, which are of sufficient importance to indicate form, is that which appears to have been part of a drinking cup. It consists of yellow ware. Its sides were perpendicular to its flat base, and it was ornamented by a double embossed line traversing the circumference on a level with the lower extremity of the handle, which was probably near the middle. Assuming this to be the case, the cup probably stood at about five inches in height, and its circumference, taken from a continuation of the measured segment, could not be less than four inches and a half. So that it was nearly as broad as high, and probably held about a pint of water.

Implements of Iron. The objects that were found made of iron were mostly in too decomposed a condition for us to arrive at any positive conclusions as to what they really were. Some appear to have been the remains of the blades of knives. Some were probably the tongues of knives that were driven into the handle; and the remains of wood still attached to them, deeply stained with ferruginous rust, support this hypothesis. Some, of which there were a considerable number taken from one spot, might have been the round points of arrows, or the armature of a buckler. They consisted generally of irregularly-shaped nodules of iron, from which a point or sharp tongue projected. There are many other pieces of irregular form.

Solitary Grave. About a hundred feet from these graves, while cutting nearer towards the sea, the labourers came upon a solitary grave, of similar character to the rest, out of which

they obtained several fragments of iron, four of which, upon being put together, were found to be the remains of a pair of scissors (Fig. 25), resembling, but about half the size of, a pair of modern sheepshears. The others were part of a knife. (Fig. 24.) The point was curved forwards, one edge of the blade being sharp; the other, forming the back of the knife, was thick and safe.

LARGE BRONZE FINGER RING. (Fig. 11.) With these last implements parts of three bronze rings were found. The largest is faced with three circular discs, the middle one being much greater in diameter than the lateral ones, which are of one size. The central one is ornamented by an embossed ring round the margin, by two oval longitudinal nodules in the middle, and by three circular nodules on each side, of which the central nodule is the largest. The lateral discs are deep, and when found were partially occupied with a white material, probably the remains of a cement that was used to fix a bead in each. The ring, which is now flattened somewhat, was evidently intended as an ornament to have been worn on the finger.

SMALL BRONZE RING. (Fig. 10.) The second ring is smaller than the previous one. Its face is merely a flattened extension of itself, and is ornamented by two rows of short vertical lines, enclosed within engraved margins. This ring, of which only a portion has been recovered, appears to have been too small to have been worn on the finger even of a female; and the circumstance of the face being at right angles with the sides, suggests that it may have been used for other purposes than that of a finger ring. Some portions of a third ring were also found, but not sufficient to enable any idea to be formed of its character with certainty. The fragment consists of small wire, flattened at one extremity, the sides of the whole being closely ribbed.

Upon the completion of the work necessary for the fortification, I applied for permission to pursue farther research. In this way I have been enabled to proceed more cautiously, and obtain a clearer idea of the positions of the things found in relation to each other.

Undoubtedly the remains appear to be very heterogeneously mingled together, but still I think the following may be relied upon as being an approximation of their positions relative to each other.

The blocks of weather-worn limestone, which appear in the first instance to be so irregularly placed, I ascertained, by tracing the circuit of the walls of the graves where it was

practicable to do so, to have been placed originally as a wall, within which the corpse was placed in a sitting posture. It is probable that some of the stones were also employed for the purpose of covering in the body.

The reason why ornaments and objects of value were buried with the dead has never been clearly established. The number of things that are found interred militates against the idea which Cæsar has affirmed to be the case with the inhabitants of antient Britain, that all their wealth was buried with them; even if we suppose that the inhabitants of a Roman colony had so far adopted the customs of the people among whom they had settled, as to have copied them in their mode of interment.

Judging from these explorations, the opinion at which I have arrived is, that it was customary, arising from sanitary purposes, or from feelings of affection, to bury with the body all the objects which the individual had possession at the time of, or during the sickness that preceded, death. It is in this way only that I can account, not only for the existence of ornaments and vessels of value, but trace a reason for the presence of pebbles from the shore, as well as the teeth of the pig, all of which I assume to have been objects of amusement belonging to the child from whose grave I took them.

In the solitary grave, the discovery of finger rings, a knife, and scissors, indicate it as the burial place of a female; but why it was separated so distantly from the rest, there are at present no means of ascertaining; but that it was intentional I think may be accepted, from the circumstance that a cutting in the rock was found to exist between it and the other graves, which the engineering officer assures me, from its appearance and character, must have originally been intended as a drain.

I offer these suggestions merely as ideas that occurred to my mind as I progressed with the research, which at present must be considered in an unfinished state, inasmuch as there appears to be a considerable extent of ground not yet explored.

ON THE TRANSMUTATION OF UREDO ROSÆ INTO AREGMA MUCRONATUM.

BY E. PARFITT, M.E.S.

THE genus *Uredo,* as established by Lévellé, consists of an interesting group of parasitical fungi found principally growing on the leaves and stems of plants, and consisting of minute or microscopical unicellular bodies, named *spores;* these are seated on a *stroma,* or thickened mass, composed of little irregular cells. The *sori,* or groups of spores, originate beneath the epidermis, and when they have arrived at a certain stage, they burst through the covering, in some instances lacerating it in a very irregular manner; others again burst through it in a very regular or even manner, either in circles or in little groups.

Some species attached to the order *graminea* rupture the epidermis longitudinally, and in linear lines; sometimes species cover the whole surface of a leaf, the little sori becoming confluent, as *Trichobasis Symphyti* found on *Symphitum officinale.* Again, some species are attached to both surfaces of a leaf, and in this case are, consequently, very injurious to the plant on which they are parasitic. In some species the spores or fruit are black, or dark brown; others white, yellow, or orange coloured. As the genus has been viewed by most mycologists, it included a number of so-called species, with short peduncles to the spores; these have been divided or separated from those having no peduncles, and have received the name of *trichobases* from Lévellé, the common *Uredo rubigo,* so destructive to our corn crops, is the type.

There are other species, or, at least, so-called species, with cylindrical septate spores, forming short, somewhat moniliform thread. This section is named *coleosporium* by Lévellé, the type of which is *Uredo Tussiliginis,* found infesting the leaves of *Tussilago farfara.* This form approaches very near to the allied genus *Puccinea,* a group very similar in habits to the former; indeed, the two genera (I still call them genera for distinction sake), approach so near each other at this par-

ticular point, that it is sometimes a matter of difficulty to separate them.

The late Professor Henslow, when working at this group of fungi some years ago, made a very important discovery, so far as a scientific knowledge of these plants is concerned, and that was, he ascertained that *Uredo unearis* was a mere juvenile condition of *Puccinea graminis*, and believed that *Uredo rubigo* was only a form of the same thing; but, as I have before stated, the line of demarcation dividing the two genera in some places is very uncertain. And in the case of *Puccinea Vincæ* and *Uredo Vincæ*, it appears to me impossible to separate them, or to distinguish one from the other, except in certain stages of their growth; for I have found in the same group of spores those of the recognised forms of both the so-called genera, and in a specimen I examined only yesterday morning, I there detected *Uredo* spores, with a partial septa, or spores in a transition state from *Uredo* to *Puccinea*.

M. Tulasne has stated as his opinion, in the "Annals des Sciences Naturales," that the greater part of the uredines are merely stylospores of *Puccinea* and *Triphragmium*, &c.; but still, I am not aware that he has proved this beyond a doubt.

Dr. De Bary and M. Tulasne have thrown considerable light on the development of these parasites, and particularly the latter author, who says, "The *Uredo*, or stylospores of *Puccinea compositarum*, sown on the leaves of *Taraxicum* or *Cirsium*, produces fertile mycelium; but a mycelium which never bears spermogonia, and never extends beyond the inoculated leaves. On the other hand, in *Cirsium arvense* the whole plant is often completely infested and deformed by the mycelium of the same *Puccinea* bearing spores, stylospores and spermogonia, leading to the supposition that the latter mycelium must be produced by a re-productive organ different from the *Uredo*." And De Bary carrying the investigation still further respecting the persistency of the mycelium in plants affected, and in this I am able to bear him out to a certain extent. He states, "that in many instances where the nutrient plant is perennial, the mycelium of the parasite remains barren in the tissue of the stem or rhizome, and pushes out its fertile ramifications into the organ of annual duration." In *Cnicus arvensis*, which is a capital subject to operate upon, the substance composing the tissues are, to a certain extent, semi-transparent, allowing the light to pass through a thin slice of it. Under the microscope the mycelium can be easily traced. The young shoots in the early spring, when first breaking the ground, will be seen crowded

with the parasite: if this be made the subject of investigation, the mycelium may be traced to its source. The mycelium does not confine itself to the softer parts beneath the epidermis, but penetrates the cell walls and harder tissues with apparently equal facility. The study of these somewhat allied plants throws considerable light upon the pest of the grape growers, *Oidium tuckerii*, which, by the by, is now considered to be a form of another species, and not distinct, as at first supposed. From this and similar instances, a degree of analogy may be drawn between these parasites and the *Entozooa*, which do not arrive at their full development until they have undergone a certain number of changes, or have found their proper *habitat*. Their analogy may be carried still further, and that is, their mode of propagation by pullulation or otherwise.

The two brothers Tulasne have contributed an important item to our knowledge in regard to the natural affinities of this group of fungi, by connecting the uredines with the *tremellæ* through the gelatinous parasites as *podisoma*, whose spores are agglutinated together into a gelatinous mass.

Having given you a short summary of our knowledge of the habits and peculiarities and natural affinities of this group of fungi, as far as is at present known, I come now to the purport of this paper, namely, the transmutation of the so-called species of *Uredo rosæ* into that of *Aregma mucronatum*.

In carefully investigating this species lately in its various stages of growth, I was much struck with the peculiar development of some of the spores, some of which I found were curiously echinulate; a fact I have never seen stated by any author. Some of the spores were very strongly so; others slightly. This echinulate development appeared to me to afterwards form the reticulated surface seen at the base of the bulb-like fruit of *Aregma*. (Fig. XII.) All the spores were not echinulate, but in some the surface was perfectly smooth. This is the case, also, with numbers of the fruit of *Aregma*, their base being quite smooth; so that this echinulate development is not absolutely necessary to the perfecting of the fruit.

Now, in the common state of *Uredo rosæ*, the fructification is as here depicted (Fig. I.—A sorus, or group of ovate smooth sporidia). These, it would appear, from what is now known respecting the persistency of the mycelium in the tissues of plants, fall off at a certain stage, and would not come to perfection, except under peculiar and favourable circumstances;

in fact, we see here what has been regarded as a distinct and perfect plant; but, in truth, is only a stage of its development, but, from its apparent persistent habit, have received the specific name of *Uredo rosæ*. Tulasne and De Bary, as before observed, had hinted that the uredines are only early states of *Puccinea*, and that each *Puccinea*, or *Phragmidium*, has its *Uredo* or *Cœoma*, which precedes it. This, it would appear, is actually the case in this we have before us. The figure of the group (Fig. I.) represents this kind of development without the septa. In Figure V. one of these sub-pedunculate sporidia is shown with a number of sporules scattered round the inside; these, I presume, would prove abortive, but in No. 3 this ovate spore, which has very much the appearance of a *Uredo*, and not a *Cœoma*, larger sporules are developed; indeed, there are numbers in different stages of development. You will observe that one large spore contains several smaller sporules, and that round a number of minute sporules a faint ring will be observed. This appeared to me, under the microscope, to be composed of a number of minute sporules attached together, forming the wall, or a kind of peridium. These, with the ones enclosed, I presume, would coalesce and form large spores, similar to Fig. IV.

The irregular form (Fig. IV.), containing elliptical sporules, is, so far as I am able to satisfy myself, an early stage of No. IX., and showing the plant before the septa of the *Aregma* fruit are developed. In No. X. you have a perfect young plant of *Aregma* semi-transparent, so as to show very clearly its internal structure; and in No. XI. we have nearly a full grown plant, with the interstices between the septa filled with yellow endochrome; and in Figure XII. we have a full grown and full coloured plant, and, so far as is at present known, its highest stage of development.

EXPLANATION OF PLATE.

I. A sorus, or group of spores. The type of *Uredo*.

II. A reticulated spore.

III. Spore, showing minute sporules; some are encircled with a delicate ring.

IV. An irregular spore, with very large elliptical sporules. These appear to me to ultimately become the endochrome in the larger plant.

V. A pyriform spore, containing sporules.

VI. VII. VIII. Reticulated spores in various stages of development.

VIII. is a stage approximating to IX.

IX. A semi-transparent pedunculated spore, containing three large elliptical sporules, and a great number of minute spherical ones.

X. A higher stage of development after the septa are formed, and the mass of endochrome becoming consolidated.

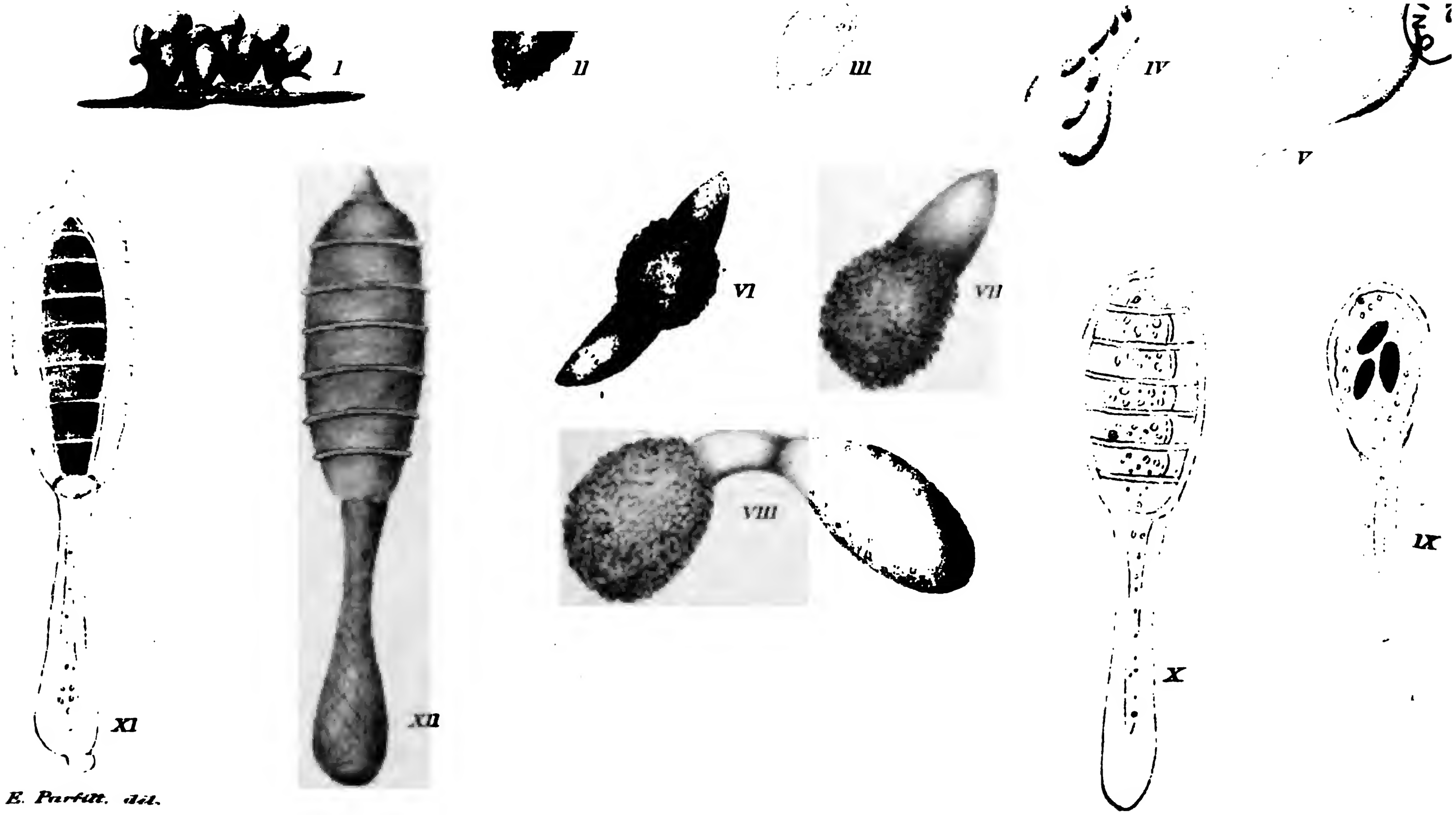
XI. A higher stage, the epidermis having assumed nearly its highest form, with the ring-like septa being developed; but the plant still semi-transparent pale yellow.

XII. The highest, or the *Aregma mucronatum* form, the base being reticulated.

ON A CORNISH KJÖKKENMÖDDING.

BY C. SPENCE BATE, F.R.S., ETC.

CONSTANTINE BAY, on the north coast of Cornwall, is formed by Trevose head on the north, and Tregarnon point on the south. At the bottom of the bay a sandy soil extends some way inland, and about a mile along the coast. It was while walking along this coast that the writer's attention was drawn to a shell-mound, near the shore. By the assistance of Mr. Spurr, and under his superintendence, extensive excavations were made, and it was found that the upper surface consisted of blown sand, mingled with a few shells, such as *Bulimus acutus* and *Patella vulgata*. In this sand the surface grass had taken root, and bound the loose material into a mass of some stability. At the depth of a foot existed a layer of sand, free from intermixture of shells or other extraneous materials; this was about a foot in depth. At this



E. Parfitt. del.

existed the stratum of shells, consisting of the common :t (*Patella vulgata*) in great abundance, the common əl (*mytilus edulus*) also very abundant, and the dog-c (*purpura lapilla*). Amongst these were found a few ıents of bone, some bits of charcoal, and some unknown like substance that was soft and friable. There were found several smooth, oval-shaped stones, consisting of ıstone, similar to such as exists in the trap-dykes at ›se head. These may have been, and probably were, l pebbles from the sea-beach, but were suitable as ham- Some fragments of broken flint were also found, but appreciable form.

neath the shell-bed was a layer of sand, in which were l the bones of the ox, deer, calf, sheep, lamb, and a horn .e roebuck, a considerable quantity of coarse pottery, segment of a ring made of wood, but which appears to nigh have become charcoal, from time.

neath the bone-bed was another bed of pure sand, several s thick; after which a stratum of coarse siliceous sand, .e gravel, of about four inches thick, mixed with earth of k colour; below which was another layer of coarse shell quartzose sand, of a few inches; then a thin bed of clay, hich were mixed small fragments of quartz and slate; lastly, the rock of the county, which in this locality sts of slate.

.e pottery found here consisted of three degrees of quality, ›est of which having a few lines engraved on the surface, 'ay of ornamentation. Fragments of one vessel were led to be put together, so as to give an idea of the size. ıs about nine inches in height, and nine in diameter; the ›m was flat, and the sides were perpendicular. They st all bore the evidence of having been acted upon by and appear to have been constructed of the clay that s the bed beneath the sand on which the shell mound The pottery, probably, was made upon the spot by the bitants of the village round which the kjökkenmödding found.

ON A BARROW IN CONSTANTINE BAY.

BY C. SPENCE BATE, F.R.S., ETC.

In the same locality, at the rear of the sandy waste on which the previously described kjökkenmödding existed, stood a small mound, enclosed by a low circular embankment about one hundred feet across; the mound rose in the centre, and stood in the middle of the enclosure.

The farmer on whose land it stood, having need of some heavy earth, carted some away. While digging near the middle, the men came upon an irregularly shaped stone, covering a pit about fifteen inches in diameter, and twenty deep. Within the pit was found a rough earthen pot, in which was a quantity of calcined human bones, and beneath the pot was found a lower canine human tooth and some fragments of flint, one of which appeared to have been the base of an arrow-head flake.

The pottery found here bears a close resemblance to that of the coarsest kind found in the kjökkenmödding, and appears to have been constructed of the clay existing in the same neighbourhood.

I take it to be a fair inference to assume, that a similar degree of art in one material in the same locality, is evidence of a unity in point of time.

I think, therefore, that the pottery of the barrow was the manufacture of the same age and people as they who made the coarsest ware found in the kjökkenmödding; consequently, the individual interred in the barrow was a prince of the people, who received the honour of cremation and a separate interment.

William Brendon, Printer, Plymouth.

INDEX

TO FIRST VOLUME OF THE TRANSACTIONS OF THE DEVONSHIRE ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, LITERATURE, AND ART.

Reference to Transactions for 1862, Exeter Meeting, marked i.
——— 1863, Plymouth Meeting, marked ii.
——— 1864, Torquay Meeting, marked iii.
——— 1865, Tiverton Meeting, marked iv.
——— 1866, Tavistock Meeting, marked v.

REPORT AND TRANSACTIONS

OF THE

)EVONSHIRE ASSOCIATION

FOR

THE ADVANCEMENT OF SCIENCE, LITERATURE,
AND ART.

[TIVERTON, JUNE, 1865.]

PART IV.

LONDON:
\YLOR & FRANCIS, RED LION COURT, FLEET STREET.
PLYMOUTH: W. BRENDON, GEORGE STREET.

1865.

CONTENTS.

OFFICERS.

1865-66.

President:

CHARLES G. B. DAUBENY, Esq., M.D., LL.D., F.R.S., &c.

Vice-Presidents:

The Worshipful the Mayor of Tiverton, W. N. ROW, Esq.
C. A. W. TROYTE, Esq. E. VIVIAN, Esq., B.A., &c.

Hon. Treasurer:

E. VIVIAN, Esq., B.A., &c.

Hon. Secretaries:

Rev. W. HARPLEY, M.A., F.C.P.S. H. S. ELLIS, Esq., F.R.A.S.

Hon. Local Treasurer:

J. G. DICKENSON, Esq.

Hon. Local Secretary:

Rev. J. B. HUGHES, M.A.

Auditors of Accounts:

W. PENGELLY, Esq., F.R.S., &c. E. APPLETON, Esq., F.I.B.A.

Council:

APPLETON, E.	HAMILTON, A. H. A.	RISK, J. E.
BATE, C. SPENCE	HEARDER, J. N.	ROW, W. N.
BOWRING, Sir J.	HARPLEY, W.	SCOTT, W. R.
BARNES, R. H.	DAUBENY, C. G. B.	VICARY, W.
GAMLEN, W. H.	MACKENZIE, F.	VIVIAN, E.
ELLIS, H. S.	ORMEROD, G. W.	TROYTE, C. A. W.
DICKENSON, J. G.	PENGELLY, W.	PARFITT, E.
HUGHES, J. B.	PYCROFT, G.	

LIST OF MEMBERS.

Allen, Rev. E., *Exe Vale, Tiverton*
Appleton, Edward, F.I.B.A., *Cotswold, Torquay*
Balkwill, Fred., *Plymouth*
Barham, T. F., M.D., *Highweek, Newton Abbot*
Barnes, Rev. Prebendary, M.A., *Mary Church, Torquay*
Bastard, S. S., *Summerland Place, Exeter*
Bate, C. Spence, F.R.S., F.L.S., &c., *Plymouth*
Berry, Richard, *Chagford*
Blackmore, Humphrey, *Garston, Torquay*
Booth, W., *Lisworny, Torquay*
Bowring, Sir John, LL.D., F.R.S., &c., *Claremount House, Exeter*
Brent, R., M.D., *Woodbury*
Cann, Wm., *West of England Insurance Office, Exeter*
Cawdle, W., *Torquay*
Cole, Robert, F.S.A., 54, *Clarendon Road, Notting Hill, London*
Colley, J., *Plymouth*
Corrie, A. J., *Wellswood Park, Torquay*
Cotton, W., *Pennsylvania, Exeter*
Cresswell, C. H., *Heavitree*
Dabb, James, *Plymouth*
Dansey, George, M.D., *Stoke, Plymouth*
Daubeny, C. W., M.D., *Oxford Villa, Torquay*
Derry, W., *Plymouth*
Dickenson, J. G., *National Provincial Bank, Tiverton*
Divett, John, *President of the Teign Naturalists' Field Club, Bovey Tracey*
Donne, W., *Torquay*
D'Urban, Major-Gen., *Newport, Exeter*
Eberlein, Herr, *Tiverton*
Elliott, W. H., M.D., *Bouverie House, St. Leonard, Exeter*
Ellis, Henry S., F.R.A.S., 1, *Fair Park, Exeter*
Evanson, —, M.D., *Torquay*
Finch, T. M.R.C.S., *St. Mary Church*
Fook, J. V., *Plymouth*
Fox, S. B., *Southernhay, Exeter*
Gamlen, W. H., *Brampford Speke*
Gill, H. S., *Tiverton*
Glanville, S., *Alphington Road, Exeter*
Griffiths, Rev. D., *Tavistock*
Gwatkin, Rev. R., B.D., F.G.S., *Torquay*
Hamilton, A. H. A., *President of the Exeter Naturalists' Club, Millbrooke, near Exeter*
Harland, C. J., *Torquay*
Harpley, Rev. W., M.A., F.C.P.S., *Plymouth*
Hayward, John, *The Close, Exeter*
Hearder, G. E., *Torquay*
Hearder, J. N., *Plymouth*
Hearder, W., *Torquay*
Hedgeland, Rev. J. W., M.A., *St. Leonard, Exeter*
Hext, Rev. J., *Kingsteignton*
Hine, J. E., C.E., *Plymouth*
Horne, F. B., M.R.C.S., *Torquay*
Hughes, Rev. J. B., *Tiverton*
Jeffery, E., *Dix's Field, Exeter*
Jones, Winslow, *St. Loyes, Heavitree*
Kendall, W., J.P., *Summerland Place, Exeter*
Kitson, W. H., *Vaughan Parade, Torquay*
Littleton, T., M.D., *Saltash*
Mackenzie, F., M.R.C.S., *Tiverton*
Miles, W., *Dix's Field, Exeter*
Moore, W. F., *The Friary, Plymouth*
Nankivell, C. B., M.D., *Torquay*
Ormerod, G. W., M.A., F.G.S., *Chagford*
Palk, Sir Lawrence, M.P., *Haldon House*
Parfitt, Edward, *Devon and Exeter Institution, Exeter*
Peacock, George, *Starcross*
Pengelly, W., F.R.S., F.G.S., &c., *Torquay*
Phillips, J., *Neve Cottage, Torre*
Pollard, W., Jun., M.R.C.S., *Torquay*
Pycroft, A., *Kenton*
Ridgway, S. R., LL.D., M.A., &c., *Marlborough House, Exeter*
Risk, Rev. J. E., M.A., *Plymouth*
Reading, J. J., M.E.S., *Plymouth*
Richardson, J., *Plymouth*
Rooker, A., *Plymouth*
Row, W. N., *Tiverton*
Rowe, J. Brooking, F.L.S., *Plymouth*
Scott, W. B., *Chudleigh*
Scott, W. R., PH.D., *St. Leonard, Exeter*
Shapter, T., M.D., *Barnfield, Exeter*
Shute, R., *Baring Crescent, Exeter*
Spragge, T., *Torquay*
Spragge, W. H., *Torquay*
Stewart, C., M.R.C.S., *Plymouth*
Teesdale, C. L., *Swiss Cottage, Exeter*
Templeton, J., M.A., F.G.S., *Exeter*
Tetley, —, M.D., *Torquay*
Thomas, J. L., *Exeter*
Tinney, W. H., *Snowdenham, Torquay*
Tracey, Rev. Eugene F., M.A., *Ford Park, Plymouth*
Trotte, C. A. W., *Huntsham Court, Tiverton*
Turnbull, A., *Parkwood, Torquay*
Turner, T., *Manston Terrace, Heavitree*
Vicary, W., F.G.S., *Priory House, Exeter*
Vivian, E., M.A., &c., *Torquay*
Vivian, R. H. D., *Torquay*
White, G. T., *Torquay*
Widger, W., *Torquay*
Withington, Capt., *Torquay*

Life Members:

Lyte, F. Maxwell
Sheppard, A. B., *Torquay*

BYE-LAWS.

The objects of the Association are—to give a stronger impulse, and a more systematic direction, to scientific enquiry, and to promote the intercourse of those who cultivate science, literature, and art, in different parts of Devonshire, with one another, and with others.

ADMISSION OF MEMBERS AND ASSOCIATES.

All persons present at the first meeting shall be entitled to become members of the Association upon subscribing an obligation to conform to its rules.

All other persons desirous of becoming members shall be nominated by a member.

All members shall pay the sum of 10*s.* annually, and have the privilege of a Lady's Ticket.

Elected members may become members for life on a single payment of £5.

Associates for the meetings shall pay the sum of 5*s.*, and Ladies 2*s.* 6*d.*

The Association shall have the power of electing Honorary Members, chosen from such eminent men as may be connected with the West of England, and Corresponding Members, from persons at a distance, who may feel an interest in this Association.

REPORTS.

The Association shall, within six months after each annual meeting, publish a Report, including the Laws, a Financial Statement, and a List of the Members.

All members who have paid their subscriptions shall be entitled to receive a copy.

MEETINGS.

The Association shall meet annually, at such time and place as shall be decided on at the previous annual meeting.

LOCAL COMMITTEES.

Each annual meeting shall appoint a Local Treasurer and Secretary, who, with power to add to their number, shall be a Local Committee to assist in making such local arrangements as may be necessary.

OFFICERS.

A President, two or more Vice-Presidents, one or more General Secretaries, and a General Treasurer, shall be appointed at each annual meeting.

The President shall not be eligible for immediate re-election.

COUNCIL.

In the intervals between the annual meetings, the affairs of the Association shall be managed by a Council appointed at each annual meeting; the General and Local Officers, and Officers elect, being *ex-officio* members.

ACCOUNTS.

The Accounts of the Association shall be audited annually, by Auditors appointed at each annual meeting.

THE REPORT OF THE COUNCIL,

As presented at the General Meeting, at Tiverton, June 28th, 1865.

SINCE presenting their last report, the Council of the Devonshire Association for the Advancement of Science, Literature, and Art have to regret the loss of several members who have been removed by death and other causes; they have, however, the gratification of being able to announce that the loss has been more than compensated by an unusually large accession of new members, so that on the whole the result of the year has been a further increase of strength.

The third annual meeting was held at Torquay, on the 20th July, when the members assembled at the rooms of the Torquay Natural History Society, and the President, E. Vivian, Esq., delivered his address. In consequence of the large number of papers which had been accepted, it was deemed advisable to deviate somewhat from former custom, and proceed with the reading of some of them immediately after the close of the President's address. Accordingly the following were then read and discussed:—

On a Mode of Preserving Iron Plating of Wooden Ships from the corrosive action of sea water	*J. N. Hearder, Esq.*
On the Denudation of Rocks in Devonshire	*W. Pengelly, Esq.*, F.R.S, etc.

On the 21st the Association met at 11 o'clock a.m., when the following papers were read and discussed:—

On Competitive and Middle Class Examinations	*J. Templeton, Esq.*, M.A.
On the Honey Bee	*S. B. Fox, Esq.*
On the Fisheries of Devon	*Dr. Scott.*
On the Transmutation of Uredo Rosæ and Aregina Mucronatum	*E. Parfitt, Esq.*, M.E.S.

On Professor Henslow's System of Teaching Botany	*W. S. M. D'Urban, Esq.*
On the Amount of Distribution of Sunshine in Devon	*Dr. Barham.*
On the Climate of Devon, with Meteorological Observations during twenty years	*E. Vivian, Esq.*, M.A.
On the Introduction of Cavern Accumulations	*W. Pengelly, Esq.*, F.R.S., ETC.
Notes on the Lake Dwellings in Switzerland	*E. Vivian, Esq.*, M.A.
On a Kyökkenmödding found on the North Coast of Cornwall	*C. Spence Bate, Esq.*, F.R.S.
On an Ancient Cornish Barrow	*C. Spence Bate, Esq.*, F.R.S.
On a Romano-British Burial Ground ..	*C. Spence Bate, Esq.*, F.R.S.
On the Four Ages	*Rev. R. Gwatkin*, B.D., F.G.S.

In the evening the members dined together at the Queen's Hotel, after which they were entertained at a conversazione given by the Torquay Natural History Society, in the Bath Saloon, when the opportunity was afforded them of inspecting some rare and valuable works of art, and also of examining more minutely several specimens which had been brought for the purpose of illustrating papers read at the meeting.

On the 22nd an excursion was made to Berry Head and the Brixham Cavern, under the guidance of W. Pengelly, Esq., who kindly explained to the excursionists the conditions under which the latter was discovered, and the nature of the explorations which had been conducted by him under the auspices of the Royal and Geological Societies.

It was decided that the next meeting should be held at Tiverton, and the following officers were appointed for that occasion:—President, C. G. B. Daubeny, Esq.; Vice-Presidents, E. Vivian, Esq., The Mayor of Tiverton, W. N. Row, Esq., J. Heathcoat Amory, Esq., J. W. Walrond, Esq., C. A. W. Troyte, Esq.; Hon. Secretaries, Rev. W. Harpley, H. S. Ellis, Esq.; Hon. Treasurer, W. Vicary, Esq.; Hon. Local Secretary, Rev. J. B. Hughes; Hon. Local Treasurers, J. G. Dickenson, Esq., R. H. Taylor, Esq.

The Council have published the President's address, together with papers and abstracts of papers read before the Association, also a financial statement, and the bye-laws.

Copies of the transactions have been sent to all those members whose subscriptions have been received by the Treasurer, as well as to the following societies:—

The Royal Society; the Linnæan Society; the Geological Society; the Ethnological Society; the Royal Institution, Albemarle-street; the Athenæum Club; the Assistant Secre-

tary of the British Association; the Exeter Institution; the Plymouth Institution; the Torquay Natural History Society; Royal Geological Society of Cornwall; the Royal Institution, Truro; the Literary Society of the Devon and Cornwall Railway Company.

The Council desire to reiterate their thanks to the South Devon Railway Company, who have continued to afford the members of the Association facilities of travelling to the meetings.

THE TREASURER IN ACCOUNT WITH THE DEVONSHIRE ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, LITERATURE, AND ART.

Expenditure.

1864–5.			£	s.	d.
Jan.	17.	Rev. W. Harpley, Hon. Secretary, for Stamps and Stationery	2	3	9
„	27.	*Western Times*, Advertisements	0	6	0
„	„	*Devon Weekly Times*, ditto	0	5	6
„	„	*Exeter and Plymouth Gazette*, ditto	0	13	0
Feb.	2.	Brendon, for printing Transactions, &c.	29	12	6
„		Maddock, for drawing Illustrations, &c.	7	10	0
Mar.	13.	*Torquay Directory*	1	4	6
„		Cockrem, for Circulars, &c.	7	3	1
„		E. Appleton, Esq., Local Secretary, for Sundries	1	3	3
		Balance	0	13	6
			£50	15	1

Receipts.

1864–5.	£	s.	d.
Balance, 1863-4	0	15	1
Life Composition from A. B. Sheppard, Esq.	5	0	0
13 Associates' Tickets	3	5	0
18 Ladies' Tickets	2	5	0
2 Associates' Tickets, by H. Ellis, Esq., Hon. Sec.	0	10	0
Subscriptions from Members	39	0	0
	£50	15	1

Examined with the vouchers and found to be correct,

W. R. SCOTT, Auditor.

27th June, 1865.

THE PRESIDENT'S ADDRESS.

GENTLEMEN OF THE DEVONSHIRE ASSOCIATION,

It is sometimes a pleasing occupation, in the evening of life, for one who, like myself, has, for many past years, watched the progress of the Physical Sciences, and endeavoured to contribute, in however humble a way, towards their advancement, to call back to his recollection their condition in his youthful days, and to contrast it with the position they occupy at the present time.

For it must be confessed, that our insight into the Mysteries of Nature, and our power of applying to useful purposes the Forces that have been revealed to us, have both been advancing at an accelerated rate during the present century.

At no former period certainly in the history of the world has one tithe of the improvements in the mechanical and chemical arts been brought about within the same space of time, and that, too, even if I were to confine myself to inventions which might trace their origin to persons with whom I have myself been from time to time brought into contact, and some of whom I may claim to number amongst my friends.

In my early days, the slow rate of land travelling, the uncertain duration of sea voyages, the tardy and expensive transmission of intelligence through the post, placed vast impediments in the way of the mutual interchange of ideas; whilst the utter inability of obtaining practical instruction in science at our universities, and even in our principal cities, rendered the path of the student a thorny and a difficult one.

More honour to those great men, who, in spite of such obstacles, carried onwards unquenched the torch of discovery, and who, in the course of so short a time, presented to their fellow-countrymen the inestimable boon conferred upon the human race, by such inventions as the Electric Telegraph,

the Locomotive, the Ocean Steamers, the Safety Lamp, Gas Illumination, the Penny Postage, and Photography.

But I will not dwell at the present moment upon subjects so trite as these, but shall confine myself to one circumstance more immediately connected with this Meeting, in which our present condition contrasts favourably with that existing in my youthful days.

It is now thirty-four years ago, that an illustrious Scotch philosopher, still living, in conjunction with the son of a distinguished prelate,—a man who at all periods of his career has evinced a strong affection for physical science, and an earnest desire to promote it,—conceived the project of assembling from all parts of the British Empire those who interested themselves in the study of nature, to discuss in common their various speculations, and to communicate their respective discoveries.

I have a lively recollection of this first scanty gathering, at York, of a body which has since been known to all the world as the British Association for the Advancement of Science, at which Meeting the only Delegate, if such he could be called, from one of our English universities, was the humble individual who now addresses you, whilst the sister University of Cambridge was entirely unrepresented, and whilst the scanty contingent supplied by the great marts of our manufacturing industry, by the Scotch universities, and by the Metropolis itself, furnished rather a mortifying contrast to the numerous list of invitations which had been issued, but under various excuses declined.

The Meeting, in short, although intended to embrace the cultivators of science from the whole of Great Britain, did not greatly exceed in magnitude that from Devonshire alone, over which I have to-day the honour of presiding; and, instead of being broken up, as has since been found necessary, into various sections, was comprehended, like the present, within a single lecture-room. Since that period the Association has passed through the ordeal to which all novel schemes are subjected, and, after being first treated with indifference and ridicule, and afterwards decried as dangerous or useless, has ultimately taken its place amongst the Institutions of the country, and been accepted as the model for all the various undertakings of the same character which have been subsequently set on foot.

It would indeed be a curious question in Statistics, to ascertain how many of those, who once cried out so lustily as to the *cui bono* of the British Association, afterwards

enrolled themselves in one or other of those Peripatetic Congresses, such as the Social Science, the Agricultural, the Archæological, the Clerical, which have been lately instituted upon the same basis.

Indeed, so far from discountenancing such meetings for scientific, literary, or religious purposes, true wisdom would be shewn in congratulating ourselves, when we find that gatherings so imperiously demanded by the spirit of the age, and the exigencies of modern civilisation, are under the guidance of men not likely to turn them to a bad account. It ought to be felt, that the great facility of intercourse, the profound peace we enjoy, and, above all, the palpable proofs which daily experience affords of the benefits resulting from the applications of science to the purposes of life, have tended to impart to physical research an importance in the eyes of the public which it was far from obtaining formerly.

You may recollect, in "Pelham," how the sordid and illiterate wife of a recluse student is represented as conceiving a higher opinion of her husband's book learning, after witnessing the respect and consideration it had secured to him from a man of fashion and rank. And so the profound researches of Faraday receive from society a fuller recognition, now that they are found to have led to such useful practical results as the Electro-telegraph, which persons wholly indifferent to, and incapable perhaps of apprehending, the great truths of science feel to be essential to their daily comfort and convenience.

And in no part of England ought the advantages of practical as well as of speculative philosophy to be more fully appreciated than in this fair county of Devon. Whilst the mines which so abound here and in a neighbouring county stimulate the activity and reward the intelligence of your practical men, they also suggest problems of the most profound interest to those who pry into the secrets of nature.

Every miner, for instance, is reminded of the gradually increasing temperature of the earth's crust by the limits which it imposes on his underground labours.

Many of your mines, indeed, already approximate to the temperature at which human existence could no longer be supported, and a striking proof was lately afforded that this temperature goes on increasing at a certain given rate as we sink lower, by the bursting out of a spring in a mine near Redruth, which, doubtless, in consequence of coming up from a still lower level than the bottom of the mine itself, raised the thermometer to 120 degrees of Fahrenheit.

Independently, indeed, of the consideration of its high temperature, the spring in question possesses several features of interest, both in a practical and in a theoretical point of view, —of practical, because it is so rich in that rare alkali, Lithia, as to promise a cheaper supply of it for the purposes of medicine and of photography than had been obtained from any previous source,—of theoretical, because the accompanying gaseous emanations place it under quite a different category from thermal waters of the ordinary description.

The latter, indeed, appear to be characterised by the evolution of two gases more especially, namely, nitrogen and carbonic acid, of which the former is the more constant, but the latter, when it occurs, the more copious; and likewise by the absence of oxygen, or its appearance in smaller proportions than that in which it occurs in the atmosphere. On the contrary, the gases exhaled from the spring which issues from the Wheal Clifford mine, at Redruth, are the same in quality and proportion as those which water takes up from the atmosphere, and would, therefore, seem to imply nothing more, than the action of heat upon the spring, causing it to expel its aëriform contents.

Here, then, a curious circumstance suggests itself, connected with the cause of the earth's increasing temperature. When we find, that a spring, which derives its abnormal temperature simply from being in contact with a rock hotter than the external air, undergoes no change in its natural gaseous constitution, are we justified in ascribing to the self-same cause those other thermal waters which we find in a greater or less degree deficient in the oxygen which they would have absorbed at the earth's surface? And if not, are we not driven to imagine some process or other to be going on in the proximity of these latter springs, by which their oxygen had been abstracted?

The question before us is also more important, because it connects itself with the general theory of volcanic operations, of which thermal springs would appear to be only an episode, not only considering their proximity to igneous vents, but also the disengagement from the latter of the same gases as those which we observe issuing from thermal waters. But if this be the case, what becomes of the theory which, excluding chemical processes altogether from a share in these phenomena, supposes a volcanic eruption to be simply due to the contraction of the external crust of the globe upon a supposed fluid nucleus, by which the liquid matter, it is said, would be forced out through fissures at the points of least resistance?

The advocates of this hypothesis appear to me to labour under this difficulty: that if they attribute thermal springs in general simply to their springing from a depth at which the crust is naturally of a high temperature, they give no account of those gaseous products which distinguish them from springs like those of Redruth, which really have no other origin. And if the internal heat of the globe be due, not to chemical processes generating heat within the crust, but to a fluid nucleus diffusing its caloric over the globe in the ratio of the proximity of each part to this centre, we assume the existence at the latter point of a temperature so exalted, that if there be any truth in the researches of Mr. Grove, all chemical affinity between the elements composing the mass would be annulled by the repulsive energy exerted by the heat. Now consider what would happen, when the constituents at a certain distance from the centre of the globe had cooled down by radiation, or otherwise, to the point at which chemical affinities began to be set up. Within this zone, oxygen would be absorbed from the air, and even from the water present; for if the constitution of the earth's nucleus be the same as that of its crust, the bases of the alkalies and earths, all of which partake of a metallic nature, and are so eager to combine with oxygen as, in some instances, even to decompose water, would there predominate.

We seem, therefore, to be placed under this alternative, either that the internal heat of the crust is due to a central fluid nucleus, in which case chemical actions ought to be taking place at some intermediate point, wherever the affinities between the elemental constituents were greater than the repulsion exercised by the heat there prevailing; or that, if not derived from any such cause, it must be occasioned by certain heat-generating processes taking place here and there with sufficient intensity to elevate the temperature of the entire crust. If the latter view be preferred, we should naturally associate these processes with those which occasion volcanos; if the former, we can hardly help imagining chemical re-actions to arise from the cause assigned, or connecting those re-actions with the eruptions and other phenomena of volcanos.

You will, I am sure, excuse me for dwelling upon this subject, as it was one which occupied my attention at an early period of my life, and which induced me to explore the volcanos of Central France so long ago as the year 1819, before any British geologist, at least since the peace, had turned his steps into that quarter, or had directed the atten-

tion of men of science to the evidences of igneous action occurring in that country, antecedently to all history or tradition.

And although other duties have since compelled me to regard this department of natural history in general rather with the eyes of an amateur than of a working geologist, I have, nevertheless, at various times, endeavoured to prosecute that one particular branch of inquiry which relates to volcanos, as being connected with chemistry, the science which, during the best years of my life, was one of my principal occupations. It is true that, in reasoning upon forces which are in operation many miles beneath our feet, and which, from the very nature of the case, can never extend to the surface of the globe, we must ever feel that we are involved in the region of conjecture rather than of actual observation; but the brilliant discoveries of a Cornishman, who, as being a native of this part of the kingdom, you may almost claim as one of yourselves, suggested an hypothesis with respect to the cause of volcanic action, which seemed to me a probable one at the time I first adopted it, and which has been confirmed by subsequent discoveries, especially through the investigations entered into by Bunsen, Deville, and others, with respect to the nature of the gases disengaged from igneous vents.*

But it is time to hasten on to another subject, in which the people of Devon are especially interested, as it derives much elucidation from the mineral structure of their own county. I allude to those researches which tend either to carry back the antiquity of the human race to a much earlier period than was before dreamt of, or else to bring down the existence of those other mammalia, which have become known to us through the bones they have left behind, to a later one than had been hitherto assigned to them.

All of you have heard, and many, no doubt, have explored, some of those caves which abound in the southern part of this county more especially. That sentiment of vague curiosity, which at all times attracts persons to explore these gloomy recesses, has of late given place to a more intelligent interest, from the aid which their contents are frequently able

* See this theory fully discussed in the 38th and 39th chapter of my Description of Active and Extinct Volcanos (second edition), published by R. Taylor, 1848, and referred to also in Supplement to ditto, p. 812; as well as in a Paper on the Eruption of Vesuvius in 1861, published in the Edinb. Phil. Journal, 1862; and in one on the Bath Waters, read at the British Association Meeting at Bath, 1864, and published *in extenso* in the Report.

to afford us with respect to the early history of man and of his cotemporaries.

I am old enough, indeed, to remember the impression which my friend and colleague, Dr. Buckland, produced upon his hearers by his vivid description of the Cave of Kirkdale, and of other places, which first rendered us familiar with the fact of the existence of the Cave Hyæna, now extinct, and of other animals, denizens of distant regions of the globe, within the compass of this very island.

But the theory he then adopted, to explain the manner in which the bones and relics of man had been introduced into these cavities, was not of a nature to encourage any systematic attempt to trace the exact juxtaposition of the latter, with reference to the bones of extinct mammalia found along with them. Thus, although it was stated by the Rev. Mr. Mc.Enery so long ago as the year 1825, that flint implements and other indications of man's workmanship had been found associated with bones of extinct animals in Kent's Hole, near Torquay, yet, as it was concluded that the former must have been introduced subsequently, no pains were taken to carry on the exploration of the cavern in that systematic and exact manner, which would have enabled the geologist to decide, whether or no the two were to be regarded as really cotemporaneous. This neglect is, as you probably know, likely to be remedied in that new survey of the locality which has been undertaken, under the auspices of the Royal Society, by Mr. Pengelly, who, in another contiguous cavern, that of Brixham, has already, in conjunction with the lamented Dr. Falconer, carried on his researches in such a manner as to prevent the same uncertainty occurring as to the position of the works of man's manufacture, which had existed in the former instance, owing to the confused manner in which the examination had been there conducted.

As a detailed account of these explorations is likely soon to appear, I shall merely observe, that even the evidences afforded in this and in other similar cases, by means of cave explorations, in favour of the antiquity of the human race, might have been disputed, had they not been backed by the occurrence of flint implements in apparently undisturbed alluvial strata at Abbeville and elsewhere.

These remarkable discoveries, now rendered familiar to all through the popular work of Sir Charles Lyell on the Antiquity of Man, seem to bridge over the gulf which previously separated the province of archæology from that of geology, by shewing that there is a field of inquiry common to both,

inasmuch as the early history of man begins, before the existence of many species of animals now extinct had come to an end.

I was deeply impressed with this truth during a visit I paid, in August, 1864, to those remarkable monoliths existing in Brittany, of which I gave an account last winter to the Natural History Society of Torquay: monuments which, in spite of their often colossal size and vast number, appear to have been put up chiefly during the stone period, scarcely any metallic implements being found in connection with them, whereas those of stone are frequently met with in the Tumuli, and representations of the same are sculptured upon the face of several of the more elaborate and better preserved Dolmens there existing.

They point, indeed, to an age of great antiquity; but nevertheless to one, in which the people were in possession of some intelligence, some organization, some kind of settled government, provided sufficiently with the means of subsistence to allow of the application of a large amount of surplus labour to the erection of these stupendous monuments, and with intellects considerably advanced beyond the narrow range of ideas which embraces only the mere necessities of our material nature. Whether they were dedicated to the Druidical or to the Serpent worship, seems a matter of pure conjecture, for other superstitions may have preceded these in order of time, arising out of those vague hopes or traditions which become the common property of mankind, so soon as ever it has emerged from that lowest grade of savage life, which is but little removed from the condition of the brute.

One inference, however, cannot but be suggested, both by the contemplation of these monuments, and likewise by those early traces of man's existence which geology presents to us; namely, that a long period of time must be supposed before the date of the commencement of historical records, in order to account for the various stages of progress which man had passed through,—from the fabrication of such rude implements as the flints we meet with at Abbeville, to that of the more elaborate and highly finished weapons of Jade and of Tremolite, which have been dug up at Carnac; no less than from the construction of those rude huts in which the primæval savage shelters himself, to the erection of such colossal monoliths, and such curiously contrived dolmens and tumuli, as at once attest the combination of many hands to effect a single purpose, and the development of the human

intellect so far, as to embrace the past and the future, as well as the present, within the range of its intelligence.

And this opens out an interesting enquiry with respect to the origin of the arts, on which subject two opposite theories have been long ago advanced, whilst a third, partaking in some measure of both the former, has of late been suggested. The first of these assumes, with Lucretius, that man, whom the poet describes at the commencement as *fœdum et turpe pecus*, was created in a savage state, and worked out for himself by slow degrees those inventions by which he was gradually raised above the level of the brute. Thus fire was first discovered through the accidental kindling of the woods by lightning, or through the friction of dry branches of trees one upon the other, when moved to and fro by the wind; thus nature herself suggested the art of sowing seed, by showing to man how shoots spring spontaneously from the ground, when acorns or berries have dropped upon it from the overhanging trees. So that, according to the poet,—

> "Usus, et impigræ simul experientia mentis,
> Paulatim docuit pedetentim progredientes."

The second of these supposes, that man was originally placed in a spot where he was surrounded with the fruits and vegetables necessary for his subsistence, and with the domestic animals, which ministered to his comforts; and that he possessed from the beginning a knowledge of those arts which, like language, and the use of fire, as well as of such implements as were required for the simple wants of pastoral life, raised him above the condition of a savage, and rendered him a responsible and moral being.

The third of these hypotheses assumes, that the human race in general was left to work out by slow degrees the primary arts necessary for its well-being, by the same efforts as those which bring about the inventions of a more advanced state of society; but that one favoured tribe had imparted to it supernaturally those capacities for improvement, and those necessary arts, which belonged to our first parents.

The latter idea was suggested some years ago in a little work, edited by Mr. Reginald Poole, entitled the "Genesis of the Earth and of Man," and found an expositor lately in Dr. M'Causland, who has embodied the same views in a popular treatise called the "Pre-adamite Man."

It is not my intention to discuss these several theories; but I may just remark, that the second and the third—either of which is more reconcileable with the statements of Holy

Writ than the first—have two facts in their favour deducible from the study of nature; namely, first, that all the fruit trees of the Greeks and Romans, with one or two exceptions, appear to have come from the East;* and, secondly, that in many races of man there would seem to be no faculties of advancing beyond a very narrow range. Hence indeed it has been imagined by some writers, that a desire and capability of progress are the attributes of the Caucasian type, and of that alone.

But in reality every family of mankind has certain limits prescribed to it, beyond which it cannot advance. The negro child learns, it is said, the first rudiments of grammar and language as readily as his white companions; but when arrived at a certain point it would seem as if his faculties could make no further strides; and hence there is no instance in persons of a pure black race of a poet, a philosopher, or an historian, although there may be amongst them skilful artificers, clever workmen, faithful and useful servants; nor have we any record of a stable government, or of any great advance beyond barbarism, in any nation composed of unmingled African blood.

And even the European, although he has a much wider scope conceded to him, and although within the prescribed limits he is capable of effecting so much, is circumscribed both as to space and time, and the more completely he obtains the mastery over his own territory, the more sensible he becomes of the small proportion which that territory bears to the regions beyond it.

Does not this reflection point to an aspect of things which it is the tendency of modern speculation to keep rather too much out of sight? The whole drift of the theory brought forward by Darwin, which has gained so wide a popularity within the last few years, is to shew how, in an indefinite succession of ages, the most complicated and elaborate forms of life came to be developed from the most simple,—how, for instance, given a spark of vitality infused into a globule of inert matter, organization and sensibility would go on extending itself step by step from cell to cell, so that even man, the most perfect of existing beings, might eventually spring from a simple monad.

As it is not possible on such an occasion as the present to enter fully into the details of this hypothesis, I shall merely

* See, for the proofs of this, my Lectures "On the Trees and Shrubs of the Antients." 1865.

remark, that it must be admitted, even by its advocates, to be as yet deficient in some of the links required to complete the chain of argument upon which its truth depends; such, for instance, as the bringing forward unequivocal cases of varieties merging by degrees into new species, or, in other words, diverging widely enough from the original type, to become incapable of producing a fertile offspring with other varieties descended from the same parentage—the filling up of those wide gaps which separate from one another the organic remains, of the older rocks more especially—the discovery of simpler and more rudimentary forms of a class or order anterior to the more perfect examples of it afforded by the strata; as, for example, of fishes of an inferior grade in Silurian rocks lower than the Ludlow in which the Pteraspis has been detected; and indeed, to speak more generally, in the traces of those earlier steps in the ladder of creation which the lowest rocks yet made known to us nowhere supply. Negative evidence, indeed, must always inspire a lesser degree of confidence than positive. Still, where Nature has been interrogated in so many quarters, and has as yet returned no response, we are almost tempted to suspect that she has nothing to reveal.

On the other hand, even its most determined opponents ought to entertain an indulgent feeling towards a theory which has guided its author into a train of discoveries, both as to the vegetable and animal kingdom, any one of which would be sufficient to establish the reputation of an ordinary observer. The husbandman would not be disposed to cry out against the enthusiasm of the speculator who, according to the old fable, dreaming of a treasure buried beneath his feet, had stirred up the land so effectually as to secure to him a succession of abundant harvests.

Men of science, too, it must be frankly confessed, are apt to entertain a leaning towards a scientific hypothesis, when they find theological arguments, like the sword of Brennus, thrown into the scale against it; for what candid and honest searcher after truth is there, whatever side he might espouse, who would not prefer to work out for himself the problem before him unaided, or, it should rather be said, unembarrassed, by such ill-timed and uncalled-for interference?

Non tali auxilio.

On this subject, however, I have little to add to those remarks which I offered in the year 1860, at a meeting of the British Association, held at Oxford, in which, whilst fully admitting that the mode of accounting for the origin of species

by natural selection, which Darwin had propounded, was beset with difficulties, and deficient as yet in the requisite array of proofs, I protested against the assumption, that man had been so far admitted into the councils of the Almighty as to be able to pronounce authoritatively, that the first introduction of a species of animal or plant upon the Globe was a phenomenon so completely *sui generis*, so essentially different from all other acts of creation, that whilst the latter are traced, without scruple, to the operation of secondary laws, instituted by the Almighty Power, and sustained by His presiding influence, this alone must of necessity be referred to His immediate and direct agency.

And if there be any who imagine, that so great an event as the advent of a new species could only have been brought about in the latter manner, they ought to be all the more disposed to adopt to a certain extent the theory of Darwin, which, by pointing out the manner in which a vast number of divergent forms might be developed by natural causes out of a single type, would tend to reduce within more moderate limits the number of these supernatural interferences.

But even assuming as proved, which I am by no means prepared to do, that all animated beings are produced through the instrumentality of secondary causes, so contrived, as to create of themselves every modification and complication of organic structure which was compatible with the existing external conditions, when once the breath of life was imparted by the Deity to the primæval monad; and granting, as a corollary from this assumption, that even man might have derived his lineage from some of the inferior links of the creation, I do not see that such an hypothesis, however revolting it may be to our feelings, or opposed to our natural prepossessions, would necessarily clash with those exalted aspirations which the study of Holy Scripture is calculated to inspire.

It has been signified to us indeed, that we are only somewhat lower than the angels, and that we are made in the image of God; but these expressions evidently refer to that immaterial principle which is infused into each of us by the hand of the Creator, and not to that perishable body which we partake of in common with the brutes, and which serves only as its instrument, and as the medium of its communication with the external world.

For what likeness can exist between a material and an immaterial substance, what analogy between the finite and the infinite, what ground for our boast of superiority to the other works of creation, if the appeal is made to our physical or-

ganization, in which we must be conscious of being outstripped in vigour of body, in activity of muscle, in quickness of perception, by many of the inferior animals? The material frame of man is doubtless ennobled by being made the abiding-place of an immaterial principle destined to immortality, just as an earthly Tabernacle would be by being consecrated to the service of the Most High; but it would be as illogical to allege the former as a ground for severing our connection with the other parts of the creation, as it would be to assume, that the latter was constructed of different materials, and upon other principles of architecture, from buildings designed for the meaner purposes of domestic life.

When, therefore, I hear such arguments adduced in order to create a prejudice against the theory of Darwin, I am apt to suspect a latent tendency to materialism in the mind of the propounder, an uneasy feeling that the higher faculties of the soul may, after all, be nothing more than the results of the mechanism of the body—like the harmony elicited by the vibrations of a stringed instrument—and begin to think that some degree of *anthropomorphism* must mingle unconsciously with his conceptions of the Deity, such as alone could render it possible for him to realize the idea, that man's perishable fabric could be framed in the image of the Eternal—a species of *Atavism*, however, which, I am afraid, is apt to break out now and then in certain minds, even after they have been indoctrinated in a higher and better philosophy.

Still, looking at the Darwinian theory, as alone it ought to be regarded, simply with reference to its scientific merits, there is much to induce us to suspend our judgment until further evidence be afforded.

In the first place, as the Duke of Argyle well observed in his speech to the Royal Society of Edinburgh, it gives no explanation of those natural arrangements which conduce to the production of beauty. "Natural selections may account for the tail of the monkey, the hind leg of the kangaroo, the elongated neck of the giraffe, as it is evident that the owners of these peculiarities are thereby the better adapted for securing their daily food in the forests or plains which they inhabit. But the same principle would offer no explanation of the graceful forms and pleasing colours which everywhere delight the eye, of the loveliness of the hyacinth and the anemone, the many-tinted scales of the butterfly's wing, or the varied brilliance which flashes from the plumes of the humming bird." "Beauty," concludes the

noble Author, "is quite obviously as much a purpose of the Creator's law as use, and beauty cannot be accounted for by natural selection."

Indeed, I may add, that it would seem as if Nature had intended to proclaim how inadequate an idea man is able to form of the great ends of creation, by lavishing, as she has done, such wonderful skill and refined mechanism upon objects, which, like the Orchis Family more especially, can only be said to minister to the gratification of the higher instincts and faculties of our nature,—by satisfying our aspirations after beauty, by sharpening our faculties of observation, and by holding out to our minds examples of contrivance and of mutual adaptation, such as are hardly paralleled in those coarser and more ordinary productions of the vegetable kingdom, which seem specially provided for the material necessities of animal existence.

Moreover, as the geologists of the present day too often limit their consideration to one class of causes affecting the earth,—those, namely, which operate by slow, regular, and successive efforts, ignoring those paroxysmal or sudden convulsions, which, there is reason to think, have had their share in producing the changes on the surface of the globe which observation reveals to us,—so our present naturalists, by having their attention riveted on the law of variation to which species are subjected through the influence of natural or artificial forces, are apt to overlook another law, which their predecessors had recognised, and which acts as antagonistic to the former.

The final cause of the law I allude to seems to be to maintain a certain fixity of character throughout nature, or rather to prevent the divergences from the original type which external circumstances bring about from ever proceeding beyond certain definite limits.

Amongst the means by which this end is brought about, we may instance,—the sterility induced by the intermixture of organisms too distinct,—the tendency to revert to the primæval type in varieties which have diverged far from the standard of the species,—the law of atavism, or the recurrence, even after a long period, of peculiarities belonging to any one of the ancestors. And, amongst the proofs that some such law exists, may be cited the persistency, from the earliest historical periods, of physical and moral peculiarities in existing races, such as the Jew, the Greek, and the Negro; together with the increasing difficulty of adaptation to new external conditions, which shews itself both amongst

animals and plants, in proportion as their organization becomes more complicated.

Nature, indeed, is a system of poises and counter-poises; and whilst the intelligence of man enables him to resist those unfavourable influences which prevent the nearest allied species—the monkey—from existing except in one particular climate, the intermixture of breeds which takes place in the inferior animals, and the contrivances against self-fertilisation, which Darwin has pointed out as occurring so generally, seem to act in the same manner amongst plants. For undoubtedly within the limits, whatever they may be, which nature has prescribed to a species, the production of a number of varieties increases the chance of some one member of the new generation being adapted to any fresh external conditions that may arise.

Thus there are two apparently antagonistic principles which the philosophers of future generations must attempt to reconcile, not by ignoring the existence of either, but by labouring to mark out the limits within which their respective influences are circumscribed. And in this way we may be enabled to determine to what cause is to be referred the dying out of a species, which seems to be as much a part of Nature's economy as the death of the individuals composing it.

According to the principles of Darwin's school, the law of natural selection would cause the existing type to be supplanted by another, whenever the external conditions had undergone a material change; whilst, according to the old view, the extinction of a species would have arisen out of the limits imposed by nature to the variation of a species, and its want of power to accommodate itself to more than a certain range of external conditions. But there are circumstances connected with this subject which seem at present scarcely in harmony with either hypothesis, and I am the more disposed to allude to them on the present occasion, as they admit of illustration by an appeal to phenomena presented in this very County.

All of you are aware, that there lies at the foot of Dartmoor, not far from the town of Newton Abbot, a deposit of wood coal, or lignite, which has, for a long time past, supplied fuel for various manufactories of bricks and pottery, although, from its offensive smell, inapplicable to domestic uses. This deposit,—through the munificence of Miss Burdett Coutts, who supplied the requisite funds for exploring it; through the exertions of Mr. Pengelly, who ransacked, one by one, the beds of lignite and clay, which, to the number of 72, alternate

with each other in the principal coal pit, and who extracted from them the fossil remains which they severally contained; and, lastly, through the botanical skill of Professor Heer, of Zurich, who determined the exact nature of these remains of a former world, with a precision which, perhaps, no other living naturalist could have equalled,—has been investigated in such a manner as enables us to fix with certainty its antiquity, and to trace the degree of resemblance which the Flora of that period bore to that existing at present in the same locality.

It has been ascertained, for instance,* that whilst the plants found in the lignite at Bovey belong to the lower miocene period, and bespeak a sub-tropical climate, the overlying gravels were deposited when the temperature of Devon partook of an arctic character. But this is not all; for the plant which, from the abundance in which its remains are scattered over the whole of this formation, from the highest to the lowest of the beds, seems more than any other to have supplied the material for the Bovey coal, is nearly related to that giant of the vegetable kingdom which has been found living in California. The name, indeed, applied to the fossil plant is Sequoia; that to the living one is Wellingtonia, the specific name of Couttsiæ being appended to the former to testify the large share that lady has had in its discovery; but the best botanists are of opinion that its cones, branches, leaves, and shoots, all of which have been exhumed from the Bovey formation, concur in indicating at least a general resemblance to the Wellingtonia. And, what is still more remarkable, this same tree, or one nearly allied to it, spread during the tertiary period over all Europe, from Greenland to Italy, and extended even to Vancouver's Island, in North America.†

How, then, are we to reconcile its present contracted range with its former wide geographical distribution? Not, as it would seem, by appealing to a change of atmosphere; for if that had been the cause, it would still have maintained its ground in Italy and other warmer regions, from which it has now entirely disappeared.

Nor are its only living congeners, namely, the *Cupressus* (or Sequoia) *sempervirens*, and the *Wellingtonia* (or Sequoia) *gigantea*, particularly susceptible of cold. On the contrary,

* See the admirable Paper on the Lignite Formation of Bovey Tracey, Phil. Trans. 1862.

† See the Memoir of C. Saporta in the *Ann. des Sc. Nat.*, 4th series, vol. 36.

the former will grow in sheltered situations throughout England, and the latter resisted, in 1860–1, weather so inclement as to have proved fatal to the Deodara in various parts of this country.

The present limitation, therefore, of the Wellingtonia within so narrow an area, seems to point to a natural law, which we recognize by its effects, without being able fully to divine the means by which it is carried out. This law is, that a certain limit has been assigned to the duration of species as well as of individuals, and that this limit is approaching in the case of the monster of the vegetable kingdom alluded to. Like the Dragon-tree of Teneriffe, or the Callitris quadrivalvis of Algeria, it is indeed vigorous where it still lingers; but, like these and others that might be named, the conditions of the climate in other respects seem to have become less propitious, although it remains to be seen whether the specimens introduced by Messrs. Veitch and Pince into their gardens at Exeter, may not show, that the tree will still flourish in a county where its congener, the Sequoia Couttsiæ, once so luxuriated.

A similar difficulty encounters us, where we meet with traces of an extinct animal in a country where the same species, or one nearly allied, when introduced anew, flourishes exceedingly. Such is the case with the horse in South America. Here, too, we seem to catch a glimpse of a still higher law, which may aim at imposing upon an organism the same limits, in point of time, which we observe in its distribution through space; or perhaps even in the extent of its power of variation, through the influence of natural selection; and if so, we may infer, that the latest discoveries of modern science are more in harmony with the doctrines of revelation, respecting man's existence on the earth having both a beginning and an end assigned to it, than was the case with the speculations of the Greek philosophers, who ascribed an eternity both to the Cosmos, and to all that it contained. And so also will they stand opposed to the dreams of perfectibility, entertained by the French philosophers of the last century, which would thus appear to be an exaggeration of, and therefore a travesty upon, those hopes of gradual, though limited progress, which the philanthropist is eager to cherish.

I have brought before you to-day, in rapid succession, some points of scientific interest, which may derive elucidation from phenomena presented in your own county, or at least in your own immediate neighbourhood.

With the same motive, I shall next proceed to the subject of Meteorology, as one peculiarly worthy of attention in a district so distinguished from all around it for the exceptional character of its climate. Devonshire and Cornwall, in fact, present a meteorological phenomenon almost without parallel in any other part of the globe; namely, that of a country occupying a latitude as high as 50 or 51 degrees, and yet mild enough in some places, not only to allow the Myrtle and the Camellia to reach the dimensions of large shrubs, but even the Orange and Lemon to bear fruit with little or no protection during winter, and the Fan Palm of Europe, the Chusan Palm of China, three specimens at least of the Dragon Tree, the Pride of India, and the Camphor Tree, to flourish together in the open air.

Considering how much of the prosperity of your favoured county depends upon this circumstance, I cannot doubt that the science which professes to explain the causes influencing the condition of a climate will possess a peculiar interest amongst those I see around me. Now, the causes affecting climate are partly of a local and partly of a general character. Of a local or special kind is the influence of the Gulf stream, a mass of tepid water flowing along the western coasts of Great Britain, and bringing with it the temperature it had acquired in those tropical regions from whence it proceeded.

And as this direction is due to the configuration of the Continent of Central America, by which the current is deflected in a north-easterly direction, it becomes a speculation of deep interest, what would happen if any physical change of the same nature as others which Geology shews to have occurred, were either to interpose a belt of land between the southern point of Florida and the West Indies, through which the current is poured into the Atlantic, or should so depress a portion of the valley of the Mississippi, as to cause the waters of the ocean to flow through it into the great lakes of North America, and thence into Hudson's Bay. Such an event, by diverting the gulf stream from its present course, might render the western coasts of Great Britain as cold as the corresponding latitudes of America, and might impart to the inhospitable shores of Labrador the genial temperature of Devonshire.

The recent explorations made in the Sahara Desert of Africa, since the French occupation of Algeria, of which an interesting account is given in the *Revue des deux Mondes* (July, 1864), by M. Charles Martins, have imparted to these speculations a reality which they did not before possess. It

has been found, for instance, not only that the desert itself is but slightly elevated above the level of the Mediterranean, but also that it is connected with the latter by a series of salt lakes, the bottoms of which are still lower, and which are divided off from it by nothing but a barrier of sand, 16 kilometres (about eight miles) in width, near the Gulf of Tripoli. Moreover it has been ascertained, that marine shells, and especially the common cockle, are scattered far and wide, from west to east, over the desert, proving that at a recent geological epoch the whole tract had been under water, and was an extension of the Mediterranean Sea. Hence, instead of a south wind conveying, as at present, to the Alps a scorching heat, and thus melting the snows on their sides and summits, the same wind, surcharged with moisture from this inland sea, would have deposited its condensed vapour in the form of snow on the first mountainous tract which it reached, and from this cause may have arisen in part that vast extension of Glaciers throughout most of the mountainous regions of Europe, which we trace as existing during a period antecedent to the present.

Thus it is that considerations of climate connect themselves with those great questions of geology which of late have been so much debated, and receive elucidation from that gradual elevation of the land above the sea's level, of which the raised beaches on your own coasts supply us with numerous examples.

But there are likewise certain general causes affecting climate upon which the recent researches of men of science have thrown an unexpected light. The most remarkable perhaps of these we owe to Professor Tyndall, of the Royal Institution in London.* Air, in a humid state, or containing much moisture in a transparent or aëriform condition, appears to exert a remarkable power both in absorbing and in radiating heat. Owing to the former property indeed, aqueous vapour acts as a kind of blanket upon the ground, and contributes in a very striking manner towards the retention of the heat which it may have acquired. Hence, when the air is divested of moisture, as on the sandy districts of Africa, in Siberia, and even in Australia, the cold at night is almost insupportable, owing to the absence of that protection which is afforded by the presence of much aqueous vapour in the atmosphere; whilst during the day the rapid abstraction of

* See particularly his Treatise on "Heat considered as a cause of Motion."

moisture from the surface of plants and animals, arising from the dryness of the air, proves equally detrimental to both.

Professor Tyndall calculates that 10 per cent. of the heat radiated from the earth in this country is stopped by 10 feet of the air which lies nearest the ground in its ordinary state of humidity. Much, therefore, of the general warmth of Devonshire is due to the dampness of the climate; not, however, be it remembered, to that portion of the water in the atmosphere which exists as vesicular vapour, and is productive of mist and fog, but to that which is diffused through the air in a gaseous form; not perceptible to our senses except by its effect in rendering the transition from heat to cold more gradual, and in equalizing that transpiration from the external surface of the body, on the due regulation of which health mainly depends.

The researches of Professor Tyndall indeed have introduced a new element into our calculations as to the causes that may influence temperature, and have suggested to him the possibility, that other parts of our planetary system may have some compensation afforded to them for the diminished supply of solar radiation, through the presence in their respective atmospheres of a larger amount of aqueous vapour, or of some other gaseous constituent possessing similar powers of arresting heat. It has, for instance, often puzzled astronomers to explain, how it happens that a planet like Mars, situated so much further from the sun, that the relative solar influence upon it, according to Professor Phillips, bears only the relation of 100 to 250,* as compared to our globe, should nevertheless appear to partake of a temperature not far removed from what we ourselves enjoy; for it is stated that the northern and southern poles of that planet are covered by a belt of snow, which during one period of the year descends to much the same latitude as it does upon the earth, and as the season advances retreats again very much in the same manner. On these data it has been surmised that the temperature of Mars cannot be very dissimilar to that of the earth, so that we must necessarily imagine the existence of some compensating principle as a means of enabling it to economize the heat which it receives from the sun, just as it has been conjectured, that the still more distant planets possess in their satellites some compensation for the feebleness of the light which reaches them from the same source.

* See his Paper on the Philosophical Transactions for 1865.

But besides the character of a climate as regards temperature and humidity, much of its salubrity will depend upon freedom from noxious exhalations; and in this respect Devonshire, from its proximity to the sea, possesses great advantages over the more inland portions of the island. It might formerly have appeared fanciful to suppose that a wind blowing over an open country could come charged with any organic matters; but the discoveries of Professor Schœubein, of Bale, seem at least to show, that differences do exist in the quality of the air at certain times and places, notwithstanding the uniformity of constitution, with regard to their primary ingredients, which the law of gaseous diffusion imposes upon them. For how otherwise can we account for the fact, that paper soaked in the solution of a salt containing combined iodine, together with a little starch, becomes blue on exposure to the air, in some states of the weather, and not in others; and that when the wind blows from the sea, this change is more likely to happen, than when its direction is more inland. Whether indeed this property of disengaging iodine from its combinations, which enables it to produce its characteristic reaction upon starch, is due to the presence in the atmosphere of that particular allotropic form of oxygen, which Schœubein has designated ozone, may be still undecided; but as a principle which is generated in the air by the electrical discharge, as well as during the slow combustion of phosphorous, possesses, together with high powers of oxidation, this particular property of setting iodine free, it seems but a fair inference, that at those times when the atmosphere is wanting in that latter power, the principle, whatever it may be, which communicates it, may have been used up, by combining with the organic matters with which it had come into contact in its progress through the countries from which the current of air at the time had proceeded.

And if there be any truth in this surmise, the abundance of this principle, which, in conformity with common parlance, and out of compliment to its discoverer, I shall continue to call ozone, in the air at a given time, will be an index of its purity, or of its freedom from animal and vegetable impurities. Hence may arise its abundance in air that blows from the sea—hence its absence from crowded dwelling-houses, or other places where animal effluvia are engendered. Its presence suggests a practical lesson as to the benefits resulting from fresh air in general, and from sea breezes in particular; it teaches us, that an amount of animal exhalation, quite imperceptible to our senses, may be sufficient to consume the ozone

which the atmosphere at any given moment contains—a circumstance of no slight importance to health, if it be true that oxygen, in that particular form which constitutes ozone, is most efficient at least, if not alone instrumental, in bringing about those chemical changes in the system, upon which health and vigour mainly depend.

Indeed, I anticipate the time, when, as the march of intellect progresses, *a well-instructed footman*, instead of saying that his mistress is gone *an airing*, will announce to the morning callers that she is gone to *inhale a little ozone;* and when by means of some more easy and unequivocal test than has been yet devised, a scale of the relative purity of the air in assembly rooms and dwelling-houses will be laid down, as a guide to assist us in maintaining within doors that condition of the the atmosphere which will be most conducive to the health of its inmates.

At any rate, regular observations on the subject are likely to throw light upon the climate of Devon; and it is to be hoped that the example set by your late President, Mr. Vivian, in carrying on a register of this and other conditions of the weather at Torquay, will be followed in other localities throughout the County.

But there is another circumstance affecting the health of the population, which also deserves your notice, and that is the freedom of the water we drink from any trace of decomposing animal matter. This is not always to be ascertained by the taste, the smell, or the sight; for a small quantity of sewage matter, such as may be imperceptible by any of our senses, has been found to produce most malignant effects upon the human constitution, as was the case, during the last visitation of the cholera, with a well in Golden Square, in London, which had previously been much sought after for the supposed excellence of its water.

In this respect also Devonshire is advantageously distinguished from many other parts of England, as its springs gush out from granite, slate, and other rocks, not capable of imparting to them any large amount of mineral impregnation, and free in general from the contamination caused by receiving the excrementitious matters of large cities. Exceptions, of course, do occur; for it appears from the report of Dr. Shapter, of Exeter, who has for many years past devoted his leisure to questions relating to climate and health, that the city in which he resides, notwithstanding the healthy and pleasant aspect it bore to a casual observer, was

in 1832 badly drained and imperfectly ventilated. Accordingly the cholera, which committed such ravages in that year throughout the country, was severely felt at Exeter, producing there a mortality of 402 persons in a population of about 28,000. But from the same excellent authority we learn, that during the second visitation of the same epidemic in 1849, although the population had increased to 31,000, the deaths from cholera amounted only to 43, of whom 13 brought the disease with them from other places.

And to what cause, humanly speaking, are we to attribute this comparative immunity? Here also Dr. Shapter's report is equally satisfactory; for it appears, that other things remaining in Exeter much as before, its sewerage and ventilation had in the interim undergone an entire revision, and full advantage had been taken of the natural facilities which the city affords for the purposes of effective drainage.

Perhaps, however, it is superfluous to pursue this subject further; for public attention has of late been so much directed to the sanitary side of the question, that the accumulation of sewerage matter within our great cities is not what is most to be apprehended. But there is another point to be considered, which, in an agricultural county like Devon, claims our most serious attention. That an enormous national loss will be sustained by carrying out the intended system of conveying away the excrementitious matters derived from our great cities, in the manner now contemplated, even the most moderate estimate of the agricultural value of such substances would be sufficient to convince us. This loss, however, we might put up with, for the sake of the sanitary improvement effected by the removal of such nuisances, if we were only sure that the drain could continue to be replaced, either directly by bestowing an adequate amount of labour upon the land, or indirectly by exchanging commodities manufactured through our own industry for the artificial substitutes requisite to make good the deficiency.

This, in a few words, is the great question now pending between several of our own scientific agriculturists, and a great German chemist, to whom, above all others, we are indebted for inculcating sound views on the principles of husbandry, and to whose opinions, therefore, on such a subject we ought to listen with suitable deference and respect. Perhaps the discrepancy between these two parties is not really so great as may be conceived; for neither would pretend to question the intrinsic value of the materials wasted, and neither would

deny that this waste is at present replaceable by the artificial substitutes which the wealth of Great Britain enables us to command, and which she must be presumed to purchase with advantage to herself, or they would cease to be imported.

To the practical mind of the agriculturist this latter consideration will doubtless be deemed conclusive, but to the man of science, who looks a little before him, the question still remains, whether, if the whole or a large part of the civilised world persevere in supplementing the waste of their natural appliances for maintaining the soil in good condition, with materials brought from a distance, the latter, from their increasing costliness, will not soon cease to be remunerative.

Such must plainly be the case shortly with guano, which probably will be exhausted in the course of the next twenty years, and although supplies of mineral phosphate are not likely soon to fail us, yet the demand for an amount of potass, equivalent to that of the phosphoric acid, which the crops require, would necessitate a larger draft upon the sources from whence it is obtained, as from the forests of the new world, and thus tend to enhance the price of that article to the consumer. Nor let us be so captivated by the sanguine reports we sometimes receive as to the profitable application of liquid manure, as to imagine that any real compensation will be thus afforded for the loss occasioned through our present system of removing from our doors the various impurities of a great city.

I could not indeed expect to be listened to, were I, a man of theory, to call in question the statements of practical agriculturists, when they assure us, that the only successful method yet discovered of utilising the sewerage of a great city is that of pouring it in a liquid state over a limited area of ground; but I must observe, that, even by their own showing, a large proportion of the potass and phosphoric acid present in the excreta are by this method lost; for whilst the total value of what each individual draws from the soil in the food he consumes annually, cannot be much less, according to Liebig's calculations, than £1, even estimating it from the materials present in the sewage, the calculated profit of the grass land irrigated with the sewerage derived from 80,000 persons in the Craigentenny meadows near Edinburgh, which is quoted as one of the most favourable cases of its application known, would not much exceed £8000, or two shillings per man.

And in order to derive an equal advantage from the sewerage of London, we must assume, that the sandy tract in Essex, intended to be irrigated by this liquid manure, will

be as well calculated to retain it as the alluvial meadows near Edinburgh, where that profit has been realized. On this question, indeed, the evidence lately afforded by Professor Anderson (*Journal of Agriculture*, No. 88, for March, 1865) is certainly more encouraging; but be the result of the experiment what it may, I cannot accept it as a solution of the great problem—what is to be done, when the artificial substitutes, on which we depend for replacing the loss sustained by our land, become so enhanced in price as to be practically unattainable? or regard it in any better light than as an instalment of those heavy arrears which our great Mother Earth has to claim from her children, and which she will inevitably demand, sooner or later, to be restored to her. For although it may be true, that we have under our very feet, in most places, an unlimited supply of the mineral ingredients requisite for our crops, yet that supply may become practically unattainable, owing to the difficulty of reducing the subsoil below a certain depth to the condition in which it will yield up to plants its mineral treasures.

Whilst, therefore, I obtrude no opinion of my own, as to the practical point at issue, I cannot, after perusing the arguments on either side, suppress my belief, that the general position taken up by Baron Liebig stands as yet unimpugned. It may, indeed, be imagined, that a momentary triumph has been gained over him, owing to his declining to take up the gage thrown down by the heads of a certain commercial company, challenging him to come over and submit to a cross-examination before a committee of the House of Commons on the questions at issue between them and him.

But surely it was too much to expect, that a veteran and distinguished foreigner should consent to quit his home and occupations for the purpose of visiting a distant country, at the beck of a knot of private individuals, under the penalty of having his scientific reputation destroyed by them if he disobeyed their summons. Even an humbler savant might, without presumption, have observed, in answer to such a threat, that a reputation which could be so easily destroyed would not be worth defending; and a person in the position which Baron Liebig has so long occupied might at least have expected that a special invitation should have been sent him, from a committee of both Houses of Parliament, before he could conceive that his declining to appear in London on such an occasion would be preferred as an indictment against him, or even as a reasonable ground of complaint.

Let me not, however, be misunderstood. I appear before you at this time, not as a partizan of Liebig's, or as an advocate of his opinions, and, indeed, am ready to admit, that it is too much to expect that his principles should be made the foundation of our practice throughout the country, so long as the present usage of importing artificial manures continues profitable.

I trust, however, that these principles will not be lost sight of in an agricultural county like Devonshire, wherein the preservation of the animal exuviæ is attended with fewer difficulties than in our crowded marts of commerce; and that they will act in inducing the husbandman to economize the refuse of his farm, anticipating that day of reckoning, which, if there be any truth in the general views displayed by the great German chemist I have appealed to, will, I apprehend, sooner or later arrive, when the impossibility of procuring mineral substitutes from abroad at prices low enough for profitable use will compel our great cities to retrace their steps, and to resort to some method of deodorising their sewerage, which may enable them to preserve the materials, as heretofore, in cesspools, without that peril to the health of the population which formerly resulted from that practice.

Such are a few of the questions now in agitation amongst men of science, which I have ventured to bring before you, selecting, in preference, from the many that presented themselves, such as were most likely to awaken the attention of the natives of this county, either as bearing most nearly upon their peculiar interests, or as deriving illustration from phenomena exhibited in their own neighbourhood.

But I ought not to conclude without some allusion to the fears which some religious persons groundlessly entertain with regard to the tendency and scope of scientific discussions, such as are carried on at meetings like the present.

In every age and country since the revival of letters, persons are to be found, who view the cultivators of physical science, or at least of certain branches of it, with jealousy and suspicion. In the age of Galileo it was the astronomer, at the present day it is the geologist, whom they regard as entertaining views which are inimical to revealed truth.

But as the more mature judgment of posterity has reversed, in the former case, the adverse sentence passed by the zealots of the Romish Church upon the first advocates of the Copernican system, so it may be hoped that the same ultimate

appeal will clear from similar imputations those who are now engaged in investigating the early Records of Creation. For it is no less derogatory to Scripture than to Science, to suppose, that there can exist any real discrepancy between the two, or any true cause of antagonism between their respective votaries.

Indeed, as truth cannot be opposed to truth, the only ground of complaint that could be set up would be, in the temper or spirit with which these two distinct revelations of God's dealings with man are approached by those who profess to expound them. And on the latter subject, so far as men of science are concerned, much misapprehension appears to exist in the public mind.

For, if it be true, as is alleged, that facts brought to light of late years through the investigation of physical phenomena, have in some instances been advanced in a spirit of hostility to revealed truth, it will be found, I believe, on enquiry, that such attacks have generally emanated from persons who could claim no share in the discoveries themselves, rather than with those who originated them; so that the latter are no more answerable for the perverse use made of their materials, than the armourer would be for the misapplication of the implements he had fabricated, after they had once left his workshop.

It may indeed be admitted, that in some instances, as the Bishop of London remarked in the excellent address he delivered in November last to the members of the Edinburgh Philosophical Society, "there has arisen, amongst men engrossed in science" (as indeed will be the case amongst those engaged in any other secular pursuit, whether it be pleasure, wealth, or distinction), "an intellectual stagnation to religious truth, so that, whilst acquiescing in the religion which is established, its truths may not possess for them a living reality. With such persons there may often be a real shrinking from any careful examination of what it teaches—they may suspect that it will not bear the touchstone of an enlightened philosophy—they may not wish to disturb it, and therefore may leave it alone, contented to be religious men on Sundays, but very bad religionists on week days in their laboratories."

But, I must observe, persons in the state of mind thus described, however liable to the charge, which the Prelate quoted has advanced against them, of neglecting higher things for the objects of their own idolatry, ought at least to be placed under a different category from the class which

thrusts itself forward in direct hostility to revelation; just as in the parable of the sower, seeds which were choked among thorns symbolize a different description of persons from those which fell by the way side.

And the case of the former is to be met, not by discountenancing free inquiry, not by holding out the study of Nature as a profane, or at least a dangerous occupation, but by fostering in them those other faculties of our spiritual nature, which exercise themselves upon higher objects, and give birth to nobler aspirations.

It is indeed in a proper balance of the intellectual and moral attributes, and not in an undue preponderance of any one, that true elevation of character consists,—a state of mind equally removed from that spiritual quietism, or that cowardly fear, which deters the possessor from unfolding the pages of the Book of Nature, as it is from that presumptuous arrogance, which closes that of Revelation as inconsistent with the readings of modern science. As, however, I presume it is not intended by any of the present generation, in the spirit of the Caliph Omar, to extinguish all secular studies whatsoever, on account of the possibility of their being perverted to irreligious purposes, I would ask the opponents of physical science, whether there be not difficulties connected with, and arising out of, the study of history and metaphysics, equal to those which are presented by the scrutiny of nature? and whether it would be fair to charge the cultivators of either with the inferences which others may have chosen to deduce from the data they have provided?

The difficulties, indeed, connected with our moral and social condition strike at the very citadel of religion, whilst those of physical science can only affect its outposts, relating, as they do, to questions which, in whatever way they may be decided, would leave the great fundamentals of Christianity wholly unscathed. It is hard, therefore, that the same safeguards which are thought sufficient against the greater danger should not be deemed available against the lesser one, and that whilst the study of history and moral philosophy is viewed without apprehension, that of physical science should be eschewed as dangerous.

And now, Gentlemen of the Devonshire Association for the Advancement of Science, it only remains that I should express my deep sense of the honour conferred upon me by my election to the Presidency of this useful Institution,—a compliment which I esteem the more, inasmuch as I cannot

claim, like the four distinguished persons who have preceded me in that Office, to be either a native of, or a long resident in, your county, although I can assure you, that amongst the may circumstances which, since I have taken up my winter quarters at Torquay, have made me feel as one of yourselves, and have enlisted my personal sympathies in the well-being of Devonshire, no one has contributed more, than the consciousness, that I have been thought worthy to aid in the great cause of advancing the progress of physical science within its precincts, which Meetings like the present are intended to foster.

THE SUBMERGED FORESTS OF TORBAY.

BY W. PENGELLY, F.R.S., F.G.S., ETC.

Considerable accumulations of vegetable matter, with stumps and roots of trees firmly fixed in blueish clay, and evidently the remains of a forest which once grew on the spot, exist in all the inlets of Torbay. The most important and best known is that which at every low water is more or less exposed at Tor Abbey Sands. It commences about three-quarters of a mile from the sea in a small valley immediately west of that in which Torre Railway Station is situated, where it is simply a thin narrow tongue of peat upwards of forty feet above the mean tide level. It extends thence through the Tor Abbey Valley to the low-water margin, and, as will be shown hereafter, there is reason to believe that it is continued sea-ward beyond the five-fathoms line. In some places it is fully ten feet in thickness, but the maximum, though undetermined, is known to exceed this amount. The sub-aërial portion is covered with about three feet of fine soil, whilst the greater part of that which occupies the tidal strand is commonly concealed by sand and shingle, but is occasionally laid bare by a heavy sea. In this, and in the similar deposits of Goodrington and Broad Sands, have been found the bones of various animals, amongst which are the red deer, *Cervus elaphus;* the wild hog, *Sus scrofa;* the horse, *Equus caballus;* the long-fronted ox, *Bos longifrons;* and the mammoth, *Elephas primigenius;* the last, if not the last two, being certainly extinct. These remains are invariably discolored, but the dark tinge is confined to the surface; the interior has a very fresh aspect, and they have lost but little of their animal matter; the last fact, however, may be due to the antiseptic qualities of the peaty mass in which they have lain.

There is no doubt of the occurrence of the remains of *Bos longifrons* in the forest, as I possess a specimen of the left ramus of the lower jaw of that animal, which with my own hands I drew out of that part of the peat which is between high and low water marks. The evidence for *Elephas primigenius,* though less direct, appears to be perfectly trustworthy.

It is as follows. A few years ago Mr. C. E. Parker purchased an elephant's tooth of some Brixham fishermen who had just taken it up in their *trawl* whilst fishing in Torbay. He at once presented it to the Museum of the Torquay Natural History Society, where, in 1860, it was seen by Dr. Falconer, who identified it as the left, lower, last molar of *Elephas primigenius*. It appears that its character had been determined previously by Professor Owen, to whom it had been shown by Mr. Godwin-Austen.*

Had this been a portion of an *existing* species it might have been supposed that it had been lost from or with some ship returning from India or Africa; but being a relic of an *extinct* animal it is obvious that it must have been dislodged from some geological deposit. That this was near at hand and that the fossil had been exposed but a very short time may be safely inferred from the facts that it is entirely destitute of marks or traces of abrasion, and that there are no marine incrustations on its surface. The dark tinge which it possesses, and which, as has been already stated, is characteristic of all the forest bones, clearly indicates its derivation; there can be no reasonable doubt that the trawl tore it out of a submarine portion of the forest.

From time to time this tooth has been mentioned by various geologists and paleontologists, who have given somewhat different accounts of the situation in which it was found. Thus Mr. Godwin-Austen, in 1851, says it was "dredged up by a trawler at the entrance of the bay."† Dr. Falconer states that I informed him that it "was dredged up in Torbay at no great distance from the shore."‡ Sir Charles Lyell mentions it twice in his "Antiquity of Man." At page 352 he says, "It is believed to have been dredged up from a deposit of vegetable matter now partially submerged beneath the sea;" and in a foot note, page 371, that "it is believed to have been washed up by the waves of the sea out of the submerged forest at the extremity of the valley in which Tor Abbey stands." As this question is connected with that of the amount of geographical change which the district has undergone within the human period, I have taken some pains to be able to make a definitive statement respecting it, especially as I appear to be responsible for the account given by Dr. Falconer. In a recent letter, Mr. Parker informs me that the tooth was found a little within and on the southern side

* Quart. Journ. Geol. Soc. Vol. vii. Page 131.
† *Ibid.*
‡ Nat. Hist. Rev. Vol. iii. Page 68.

of Torbay. From the situation, the depth of water must have been fully five fathoms; and this is confirmed by the fact that this depth is scarcely sufficient for trawl-fishing.

It is probable, therefore, that the remains of the ancient forest occupy the greater part of the Torbay area. Nor is this a merely modern opinion, since Leland, in his "Itinerary," the materials for which he collected between 1530 and 1540, says, "Fisschar Men hath divers tymes taken up with theyr Nettes yn *Torrebay* Musons of hartes, whereby men judge that yn tymes paste it hath beeen forest grounde."*

Though no trace of this forest is now to be seen in the Brixham inlet, within the recollections of persons still living the site of the principal street of lower Brixham was a peaty willow plot; and it is well known that its present surface was formed by the artificial lodgment of material so as to raise, by several feet, the bottom of the valley.

Descriptions have frequently been given of numerous forests of this kind which occur along both the northern and southern coasts of Devonshire and Cornwall; it is probable, however, that many exist which have never been recorded, and which, indeed, are but rarely seen. For example, the picturesque valley of Blackpool, about two and a half miles south-west of Dartmouth, terminates at the sea in an extensive beach of very fine sand. Ordinarily there is not a vestige of submerged forest to be seen; nevertheless I have been informed by Mr. Thomas Newman, and other eye-witnesses of the most unquestionable veracity, that in July 1802 a heavy sea swept off the sand and exposed a considerable number of large trunks and branches of trees lying on and in a blueish clay; they were covered again with sand in so short a time that a large number of persons who went to see them were disappointed. About ten years since, this mass of vegetable débris was disclosed once more, in the same way and for a similarly short time; but there is reason to believe that between these two occasions it was never laid bare. For half a century, then, no one could have detected its existence. Two generations of geologists might have visited the locality daily without a suspicion of what lay beneath the sand.

It is well known that what are appropriately called Raised Beaches are just as numerous and as widely distributed as the Submerged Forests. Excellent examples present themselves in the district immediately under consideration, and many of them have been fully described; as for example those at

* "The Itinerary of John Leland, the Antiquary," vol. the Third, Third Edition, pages 54, 55, Oxford, MDCCLXIX.

Hope's Nose, on the Thatcher Rock in Torbay, at Berry Head, Sharkham Point, and Blackstone Point south of Dartmouth harbour. New ones, however, are constantly coming under notice; and during the past year, 1864, two fine examples were discovered; one of them situated immediately north of Dartmouth harbour, and the other along the entire coast from Hall Sands to the Start Point. They occupy ledges or platforms which the waves have cut in the hard limestones and slates, and are from twenty-five to thirty feet above the ordinary sea level. In most cases they are distinctly arranged in strata, of which the uppermost are composed of fine sand and the lowest of large boulders and pebbles, many of the latter being flints. They incline sea-ward about as much as does an ordinary existing tidal strand, and, so far as has been observed, they have neither contortions, faults, dislocations, nor any other indications of violence. Most of them contain marine shells, all of which belong to species still existing in the adjacent sea; hence they do not take us back to the Pliocene era, that is, to the most modern period of extinct molluscs. Now the Raised beaches cannot be the contemporaries of the Submerged forests: the former require the country to have been thirty feet lower, the latter at least forty feet higher than at present; and from the widely-extended distribution of both, it is impossible to ascribe either of them to very local changes of level. To suppose the forests the more ancient, is to suppose their submergence to have been thirty feet greater during the chiselling of the rock platforms and also during the subsequent accumulation of the beaches on them; so that throughout this lengthened period very much of that portion of the peaty accumulation which is now sub-aërial would have been submarine, and, therefore, in all probability covered with sea-sand, gravel, and shells; but no trace of such materials is found anywhere overlying the vegetable deposits beyond the reach of the waves at the existing level of the land.

From the foregoing facts it appears safe to draw the following inferences:—

1. That the Submerged forests are more modern than the Raised beaches—an opinion held by all who have recently written on the question.

2. That after the completion of the beaches, the entire district was uplifted at least seventy feet before the forest flora took possession of the soil which its remains now occupy.

3. That, subsequently to the forest era, there was a general

subsidence to the amount of certainly forty, and perhaps of many more feet.

4. That the forests are of sufficient antiquity to have sheltered the mammoth and long-fronted ox, but that they fall very far short of the era of extinct molluscs.

5. That the successive changes of level were at least tolerably uniform, and were effected gradually.

It may not be out of place to add a few remarks to the inferences or propositions just enunciated:—

Whilst it is impossible to avoid the conclusion, that between the Beach and Forest eras a change of level to the amount of seventy feet took place, there does not appear to be anything to prove that the upheaval was not much greater. The facts require, as a *minimum*, the amount specified; but they are perfectly compatible with anything beyond this. Indeed, Mr. Godwin-Austen refers the forests to a period "*of an elevation of great amount, such as would place the whole of the higher portions of this country in regions of excessive cold.*"* Though this question does not affect that of the sequence of events, it is not without an important bearing on that of their duration. It is scarcely possible to study the phenomena of the beaches or of the forests without a conviction of the gradual character of the movements, both upwards and downwards, which left unchanged the inclination of the marine beds, failed to produce on them a trace of paroxysm, and permitted the roots of the trees to remain spread out in the soil with their stumps as vertical as when they grew. And when these characteristics, both positive and negative, are found to be again and again repeated along very many miles of coast, the conviction becomes resistless that Convulsion was not employed in their production. Were additional evidence required, it would be found in the fact, that the old rocks on which the beaches have been reared are traversed by numerous divisional planes—cleavage, joints, and fissures—which would certainly render it easy for Catastrophe to throw them into wild confusion, and with them the modern beds which they support. But if the movements were thus slow and tranquil, their duration must be a direct function of their amount. The greater the height of the country during the forest era, the greater was the previous upheaval, as well as the subsequent subsidence, and the greater also the probability of the intercalation of periods of intermittence. Every additional foot, therefore, beyond the indispensable seventy, renders, at least, a *proportionate* augmentation of time inevit-

* Quart. Journ. Geol. Soc. Vol. vii. Page 130, &c.

able; and pushes, by so much, the raised beaches further back into the abyss of antiquity.

That the forests, which contain remains of *extinct* mammals, should be regarded as more modern than the beaches in which are found only the shells of *existing* species of molluscs, may at first appear to be paradoxical; but it can scarcely be neccessary to remark here, that the species of animals at present occupying the earth were by no means coeval in their origin. The advent of some of them may have been but little anterior to that of man, whilst many others date from a much greater antiquity. As a rule of considerable generality the lowlier the organism the greater has been its duration on the earth. The specific life of a mollusc, therefore, greatly exceeds that of a mammal, and takes us much further back into the past.

Since remains of the mammoth were found in considerable numbers in the celebrated Kent's Cavern, Torquay, the occurrence of a tooth of this extinct proboscidian in the Torbay forest raises the question of the age of the latter in relation to that of the bone-beds of the caves—a question on which there appears to be some diversity of opinion. The late Sir Henry De la Beche, when treating of the Caverns and Submerged forests of South Wales, says, "Indeed, when contemplating from any of the adjacent heights the range of country which includes the estuary of the Burry and the Llwchwr, with its submarine forest and also one of the limestone caves of that part of the country, wherein the remains of hyænas, rhinoceroses, and other animals are found, the cave's mouth fronting, and not far above the range and level of the 'forest,' an observer has some difficulty in very clearly separating the time when the forest grew and the red deer of the present time, the great extinct ox, and the rhinoceros may have ceased to be contemporaneous, anterior to the submergence of the land beneath the level of the adjoining ocean, in such a manner that not only the stumps of trees remained rooted in the ground in which they grew, but the footprints of mammals which roamed amid the forest of this period also remain uninjured during the time when they were covered over by silt and sand."* Mr. Godwin-Austen, speaking of the bones found in the forest ground, and especially of the molar just mentioned, says, "These remains are of much interest, as they serve to connect the age of this forest ground . . . . with the period of the animals whose remains occur in the caves of the

* "The Geological Observer." Page 521. 1851.

adjoining district."* And in the Tabular View at the end of his paper, he denominates the period to which he assigns the forests, as that in which the "large mammalian fauna was at its maximum." Sir Charles Lyell, on the contrary, when speaking of the same tooth, says, "This individual elephant must certainly have been of more modern date than his fellows found fossil in the gravel of the Brixham Cave . . . . for it flourished when the physical geography of Devonshire, unlike that of the cave period, was almost identical with that now established."† Had the mammoth been a species of short duration, Mr. Godwin-Austen's opinion would of course be, at least, approximately correct; it would, however, involve us in considerable difficulties. But the specific life of this great pachyderm is known to have been of enormous length. Its remains have been found in England in both pre-glacial and post-glacial deposits: it existed in Tertiary and also in Quaternary times. "The Mammoth," says Dr. Falconer, "is emphatically entitled to the significant name proposed by Geoffrey St. Hilaire, in one of the brightest inspirations of his latter years, of '*Dicyclotherium*,' as having by a 'miracle of Providence' survived through two epochs."‡ The contemporaneity of the cavern deposits, therefore, is not proved by the occurrence in each of them of the remains of this species. For the solution of this problem, we must turn to physical evidence.

The systematic exploration, in 1858, of Windmill Hill Cavern, at Brixham, showed that the bed of cave-breccia, consisting of reddish loam with angular, sub-angular, and rounded stones, and containing bones of extinct and recent animals mixed up with human implements fashioned in flint, had been introduced by a small engulfed river at a time when the adjacent valleys were about one hundred feet less deep than they are at present; and it has been already stated that the forest occupied the bottom of the principal of these very valleys; which, therefore, must have been deeper than it is at present before the plants took possession of it. In other words, the *close* of the cavern period preceded the *commencement* of the forest era by an interval sufficiently long for the excavation of valleys one hundred feet in depth.

Let us next inquire whether the Submerged forests afford any evidence of the antiquity of man. In 1852, Mr. Ardley, a well-known respectable tradesman of Torquay, accustomed

* Quart. Journ. Geol. Soc. Vol. vii. Page 131.
† "Antiquity of Man." Third Edition. Page 352.
‡ Nat. Hist. Rev. Vol. iii. Page 72.

from childhood to natural history pursuits and observations, found parts of several horns of the red-deer in the sub-aërial portion of the forest in the Tor Abbey Valley, in which extensive draining operations were then in progress. Two of the specimens, presented by him to the Museum of the Torquay Natural History Society, were found lying together about two hundred feet from high water mark, twelve feet below the surface, and not less than nine feet below the level of high spring tides; in other words, they were nine feet deep in the peat, over which lay three feet of fine soil, and, as nearly as possible, they were at the mean tide level. The largest of the two specimens has on it several marks of human workmanship, all of which appear to have been so directed as to produce a piercing tool. In the first place, its larger or basal end shows that it was severed from the head partly by being cut with some sharp instrument and partly by being broken. Moreover, there are six marks or incisions, also of a sharp tool, a very little above the line of severance, which suggest the idea that they were made perhaps with some kind of chopping implement. Secondly, a branch, probably inconveniently situated, was removed also by cutting and breaking. Some of the cuts in this case indicate a keen-edged implement, whilst others imply a somewhat blunt one. Thirdly, the point of the most prolonged of the two remaining branches was rendered more taper than nature had made it, by cutting probably in the first place, and subsequently by polishing, and thus the desired tool was fashioned. Fourthly, the artist appears to have aimed at the formation of an instrument with two points; for the extremity of the second or shorter branch has on it numerous cuts, all designed to produce a more tapering form; apparently, however, in this part of the work he was so unfortunate as to break off the tip, when he gave up the attempt without proceeding to the final or polishing stage. This accident in no degree interfered with or impaired the efficiency of the implement into which the other branch had been formed.

Though the foregoing evidence is so direct and trustworthy that no one can entertain a suspicion of deception, or hesitate to believe that the cuts were made prior to the inhumation of the horn, it is satisfactory to be able to point out that their own character is fully sufficient to establish their claims to antiquity. As has been already remarked, the discoloration of the forest bones is confined to their surfaces: beneath the merest film they are perfectly white. Now, had the cuts been modern ones, made, as in that case they must have

been, after Mr. Ardley drew the specimen out of the peat, their white colour would tell the tale at once; on the other hand, if the cuts were made before the lodgment of the horn in the vegetable débris, their surfaces would have the characteristic dark tint of the fossils. In short, "dark," "ancient," "truth," and "white," "modern," "deception" are here respectively convertible terms. After what has just been said, it must be unnecessary to add, that the surface of each cut is as dark as that of any other part of the horn: there can be no doubt that this rude tool was fashioned by a man of the forest era.

It may perhaps be objected that there is here no proof of the contemporaneity of man and the mammoth, since the tool of the former was found in the *sub-aërial*, and the tooth of the latter in the *submarine* portion of the forest, with an interval of four miles between them. The objection, of course, will be admitted at once to be perfectly valid; but in order to turn this point to account the objector will find himself under the necessity of doing two things: he must admit, and, indeed, contend for the great chronological value of the forest; and he must prove, or at least show that it is probable, that the molar was deposited before, and not after, the antler.

A few remarks on each of these points may be introduced here; and, to take the last question first, it must be borne in mind that every part of the forest area was submarine immediately prior to the forest era, also that it was shown to be eminently probable that the upheaval by which the whole became sub-aërial was slow and gradual; hence the highest level emerged first, the lowest last; and the area occupied by the tool must have been above the sea, and fitted for a forest growth very long before that in which the tooth was buried, since the former was at a level fully thirty feet higher than the latter. This being so, the probabilities, so far as they go, are in favour of the implement being more ancient, rather than more modern than the relic of the elephant. Further, to suppose that the upheaved district remained untenanted by plants until the emergence of the lowest level, and that the forest commenced existence then and there, and gradually overspread a region which it might have possessed very long before, is to squander the probably enormous period during which the land was slowly creeping up to a thirty feet higher level: a prodigality in which, as will now be shown, the objector would be most unwise to indulge.

And now to turn to the first point. By whatever interval

we separate the two fossils, by so much do we enhance the antiquity of the pre-forest phenomena, such as the bone-bed of the caverns, and of the men whose flint implements these beds contain. The geologist affirms that, slowly and reluctantly, he has announced his belief that there is conclusive evidence that since man existed in Devonshire, valleys of one hundred feet in depth have been excavated; that this work must have been completed prior to the commencement of the forest growth; that since the termination of the forest period, the entire district has been carried down at least forty feet vertically; and that, waiving the question whether certain facts do not indicate a subsequent and upward movement, the last adjustment of the relative level of sea and land was so remotely ancient as to give the waves time enough to cut broad platforms of denudation in even hard limestone rocks, as on the south side of Hope's Nose in Torbay, whilst in the new red sandstone district, as may be seen near Budleigh Salterton, the breakers assail the cliffs at high water, and at low water fall half a mile short of them. He is of opinion that these changes compel him to assign a very high antiquity to the advent of the human race in Devonshire, to say nothing of the first appearance of man in our planet. He is willing, on the receipt of sufficient evidence, to accept the proposition that the man who fashioned the antler-tool of the sub-aërial portion of the Torbay forest was not the contemporary of, but was more modern than, the mammoth whose molar the trawl tore out of the submarine portion of the same deposit; but this he cannot do without correspondingly increasing the previously great chronological demand which he felt compelled to make on behalf of the human period.

The idea that man witnessed the submergence of the forest ground is by no means a novelty. St. Michael's Mount, in Cornwall, is sometimes an island, sometimes a peninsula. In ordinary cases the space between it and Marazion—about one-third of a mile—is dry about four hours during every tide; occasionally it amounts to five hours; and instances occur now and then, at a conjuncture of unfavourable neap tides and very stormy weather, when for two or three days together it is impossible to walk to the Mount. The isthmus consists of the outcrop of beds of Devonian slate mixed with greenstone, and is, more or less, covered with sand and shingle.

Dr. Boase, writing of this picturesque spot, says, "Saint Michael's Mount was named in Cornish, as Carew informs us, '*Caraclowse in Cowse*,' *or the hoare rock in the wood;* . . . . .

Later historians state that Florence of Worcester expressly asserts that it was formerly five or six miles from the sea, and enclosed with a very thick wood, and therefore called in British, '*Carreg lûg en Kug*'—'*Le Hore Rock in the Wodd.*'"*

Dr. Boase, in the same paper, has also described a submerged forest between the Mount and Newlyn, which is seen under the sand in the form of black vegetable mould, and containing the remains of forest trees, all of indigenous species. Here, then, we have apparently the very "wood" to which the traditional name points; hence, as Sir C. Lyell has remarked, "there seems evidence of the submergence having been effected, in part at least, since the country was inhabited by man."† The late Sir Henry De la Beche, however, on purely hypothetical grounds, thinks "it may be considered doubtful how far this submarine forest affords any support to the old traditional name of the Mount."‡ There is nothing surprising in Sir Henry's scepticism, for holding, as he did, that the forest belonged to an earlier period than the Raised beaches, that, indeed, they were coeval with the cavern deposits, he could not believe that the old Cornish language was older than the era of submergence, without assigning to man a much greater antiquity than even the most advanced geologists would at that time (1839) have tolerated. Sir C. Lyell, on the other hand, believed the forest period to be posterior to that of the caves and beaches, and could therefore, so early as 1840, consistently use the language quoted above, though his avowal of a conviction of the antiquity of man was first made in his memorable opening address as President of the Geological Section of the British Association, at Aberdeen, in 1859.

Though, as has been shown, very considerable coast changes, effected by ordinary wear and tear, and implying a great lapse of time, have occurred since the last adjustment of the relative level of land and sea, it has been asked whether it is not possible that the submergence of the forest ground happened within the range of authentic history. In reply it may be sufficient to quote the following passage from the writings of the late Sir G. C. Lewis:—"Diodorus describes Britain as being like Sicily, triangular, but with sides of unequal length. The promontory nearest the mainland was called Cantium (Kent); that at the opposite extremity was called Belerium; that turned towards the sea was named Orca

* Trans. Roy. Geo. Soc. of Cornwall. Vol. ii. Page 134.
† "Principles." 6th Ed. Vol. ii. Page 80. 1840.
‡ Report of Cornwall, &c. Page 418. 1839.

(a confusion with the Orcades). The inhabitants of the promontory of Belerium were hospitable, and, on account of their intercourse with strangers, civilized in their habits. It is they who produce tin, which they melt in the form of astragali, and they carry it to an island in front of Britain, called Ictis. This island is left dry at low tides, and they then transport the tin in carts from the shore. Here the traders buy it from the natives and carry it to Gaul, over which it travels on horseback to the mouths of the Rhine."* Dr. Barham, of Truro, in a paper read in 1825, has fully established the identity of St. Michael's Mount with the Ictis of Diodorus, who wrote about 9 B.C. Hence the submergence was certainly prior to this date.†

I am not unmindful of the fact that this early trade in Cornish tin has been entirely denied; but surely this question was set at rest for ever about forty years ago, when a block of tin was dredged up at the entrance to Falmouth harbour, and placed in the Museum of the Royal Institution of Cornwall. Colonel Sir Henry James, in a very ingenious paper on it, states, on the authority of Professor Owen, that the peculiar form of the block was properly described by Diodorus as in the form of an astragalus or knuckle bone.‡ Sir Henry is of opinion that the argument based on the old designation of the Mount is easily disposed of; for he says that at present "there are trees growing on the Mount, and in sufficient numbers to have justified the ancient descriptive name of 'the hoar rock in the wood.'" Having formerly been very well acquainted with the spot, I was totally unprepared for this statement, and to satisfy myself respecting it I visited the Mount in July last (1864), and more recently I have had an opportunity of going over it a second time. There are certainly some hazel and tamarisk bushes growing there, but it would be a very great stretch of courtesy to call them trees; moreover, if every available nook on the semi-island were occupied by a tree, the aggregate would fall very short of my notion of a wood: and it should be borne in mind that a people so well acquainted with woods as were the early British would not be likely so to magnify a few trees as to give them such an appellation. But waiving this point, and making the most of the case, it could amount to no more than a wood *on* a hoar rock, and never could have been a hoar rock *in* a wood. The ancient Cornubii must have been

* "Astronomy of the Ancients." Page 452.
† Trans. Roy. Geol. Soc. of Cornwall. Vol. iii. Page 86, &c.
‡ Forty-fifth Ann. Rep. of the Roy. Inst. of Cornwall. Page 32. 1863.

largely gifted with the poetic faculty, if ever under existing geographical conditions they gave to the Mount the name which tradition assigns to it; though once given, it would probably be retained long after it had ceased to be appropriate. The vegetable remains beneath the sands of the bay prove the existence and submergence of a recent forest; the passage from Diodorus Siculus proves the submergence to have taken place before the Christian era; whilst the antler-tool of the Torbay forest shows that it occurred after the arrival of man in the south-western horn of Great Britain.

ON

THE FELDSPATHIC TRAPS OF DEVONSHIRE.

BY W. VICARY, F.G.S.

TRAPPEAN rocks are of frequent occurrence in Devonshire; and in the south of the county they are so mixed up with the stratified formations as sometimes to render it very difficult for the geologist to determine the exact sequence of events. The Devonshire Traps are of two kinds—Greenstone or Hornblendic, and Felstone or Feldspathic; the former being associated with the Devonian and Carboniferous formations, the latter with the more recent Trias. It does not necessarily follow, however, that the Hornblendic are older than the Feldspathic series, as the former are sometimes of later date than the formations with which they occur. In this paper I purpose confining myself to the Felstone Traps, simply because I have had greater opportunities for studying them.

Geography of the Feldspathic Traps.—An inspection of the geological map of Devonshire shows that the Feldspathic traps make their appearance at or near the junction of the Carboniferous and Triassic formations, from Washfield, near Tiverton, on the north, to Haldon on the south. They extend westward along the strip of Trias which runs from Bradninch to Jacobstow, and occur frequently along both north and south lines of junction of the two formations as far as Greenslade, near North Tawton. No trap rocks are met with in the whole range of Triassic cliffs from Torquay to the Axe; possibly they may be too deeply seated for observation. I have observed them in the following localities in addition to those indicated in the map of the Geological Survey of Great Britain:—Holmead, about two miles west of the mass extending from Washfield to Loxbeare; Fishford, near the South Western Railway Station at Broadclist; Pitt, about half-a-mile north of Silverton; and Stone, Crook, and Greenslade, near North Tawton.

Whenever the geological surveyors revisit this county they will find it necessary, I believe, to modify the trappean symbols which are given in the existing map. For example,

the mass now represented as a whole, and made to extend from Pullins northward by Pocombe to near Willow Hayes, should be divided into two distinct and separate parts; for in a small valley at Little Barley the Carboniferous slate reaches the surface, and shows that the Pocombe trap is severed from that at Old Close quarry; whilst the latter can be connected easily with that behind Great Barley House, so as to give this northern portion a north-west and south-east direction. Again, the narrow strips of colour which at West Sandford indicate trap, should be united, and the entire mass greatly enlarged. It should also be prolonged northwards to meet the Carboniferous strata near New Buildings. I believe this trappean area to be much larger than that at Posbury, south of it, which, on the map, requires diminution and alteration of outline.

Lithology of the Feldspathic Traps.—It is impossible to give anything approaching an exhaustive lithological description of the Feldspathic traps of this county, as several varieties are frequently found, not only in the same mass, but in the same quarry. In this part of my investigations I have had the valuable assistance of Mr. Etheridge, of the Geological Survey, to whom I have submitted hand specimens from all the principal localities, and whose notes and memoranda are embodied in the following description:—

1. "Vesicular Feldspatho-hornblendic trap, resembling the Peperinos or Tuffs of Italian geologists, and closely allied to the trap-ash series." It is more or less vesicular from top to bottom of the present workings, and when first quarried is so soft as to be capable of being cut with a hatchet. Localities: Beere, Thorverton, Rew, and the neighbourhood of Silverton. Curious lines or rows of vesicles, sometimes two or three inches thick, traverse the quarry at Rew, and give to the mass an appearance of rude stratification.

2. "Basaltic and fine-grained, with quartz crystals all through it, resembling the glassy quartz of felstone rocks generally, and which, by some geologists, is called glassy feldspar; jaspery veins, and a free feldspathic mineral (allophane) decomposed occur in this." Locality: Stone, near North Tawton. Lithomarge occurs in the trap at Stone, and also at Haldon.

3. "Fine-grained feldspatho-porphyritic basalt, with fine-grained glassy feldspar, olivine, and augite." Localities: Knowle, and Western Town, near Exeter.

These traps (2 and 3) are too hard and fragmentary for building, but are used in road-making. They are generally

vesicular near the top of the mass only, but at Western Town the vesicles occur at both top and bottom, but do not occupy the intermediate zone. Those at the bottom are filled with mealy zeolite. The Knowle and Western Town Traps differ in colour from the neighbouring mass at Haldon. The latter is also less compact, and contains small decomposed crystals of hornblende. In the lane leading from the Haldon Belvidere to Doddiscombleigh, veins of oxide of iron are seen passing through the trap.

4. "Vesicular feldspatho-porphyritic trap, with what appears to be decomposed zeolite (not *lime*); it may be finely reduced feldspar, though perhaps rather too aluminous." Locality: Pocombe.

5. "Amygdaloidal porphyritic felstone, with green crystals, which may be augite or allophane." Localities: Posbury and Pocombe.

6. "Porphyritic Ash, with a dike-like line which appears to be an elvan." Localities: Posbury and Pocombe.

7. "Feldspathic trap, with crystals of pyroxene and much chlorite." Locality: Pocombe.

8. "Apparently a reconstructed trap or conglomerate, the amygdaloidal cavities contain zeolitic dust like others of the same character." Locality: Bottom of Pocombe rock.

The traps (4 to 8 inclusive) are much used for building, and, if well selected, are very durable. The Northernhay Rock at Exeter, from specimens of it seen in walls in the city, seem closely to resemble those of Pocombe and Posbury. It cannot now be inspected *in situ*.

9. "Chloritic trap, with lime in abundance, and much Green-earth; this may be an ash." Locality: Raddon Court.

That the Raddon Court trap has been extensively quarried for a great number of years, is proved by the great accumulation of refuse in the quarry, on which large trees are now growing. Many churches and bridges in the neighbourhood have been built with it.

10. "Micaceous porphyry, containing olivine and lime." Locality: Killerton.

At Killerton the rock is only vesicular on the top. It differs from those at Culmjohn and Budlake, which belong to the same mass.

11. "Feldspathic trachyte, with decomposing hornblende: it does not contain lime." Locality: Barley House quarry.

12. "Resembles porphyritic clay, or one of the argillaceous felstones; it is scarcely crystallized or altered. It may be a completely decomposed trap. It is igneous in its origin." Locality: Poltimore.

The Traps (11 and 12) are soft, and break into small fragments for common use.

13. "Fine-grained argillaceous felstone or claystone, with remarkable concentric concretions. This may be a sedimentary volcanic ash. It is the Thor-stein of the mineralogists of Saxony." Locality: Greenslade.

At Washfield quarry the working is less than twenty feet deep, and the trap is vesicular throughout. It is also micaceous; and Professor Tennant detected in a hand specimen minute plates of selenite. In Loxbeare quarry it is still micaceous and similar in structure, but white in colour. At Holmead the trap is more compact, and contains much mica, which is so arranged as to give the rock the aspect of mica schist.*

Petralogy of the Feldspathic Traps.—At Haldon and Killerton the traps occur in broad irregular masses; elsewhere, however, they commonly appear as dikes, filling fissures in the earlier rocks, and having their longer axes nearly at right angles to the direction of the dip of the adjacent Trias, which over a considerable area is towards the south, whilst the strike of the trap in the same district is east and west. The reverse of this, however, obtains at Pocombe, where the Trias dips towards the east, and the trap strikes north and south. In short, it is a fact of large generality, that the strikes of the two formations coincide in direction. It may be remarked here that Howell and Geikie, in their report on the trap rocks of Scotland (page 650), point out the fact that in North Britain the strike of the one formation takes the same direction as the dip of the other.

It has been stated already that the felstones of Devonshire generally appear near the junction of the Carboniferous and Triassic formations; and it may be added that, as a general rule, the longer axes of the trappean masses are parallel to the adjacent lines of junction of the Triassic and Carboniferous rocks. These facts have, to some geologists, suggested the idea that the line of junction was a line of least resistance; but we have no reason for believing that the area occupied by the Trias now is of the same extent as formerly. In fact, the numerous Triassic outliers afford good evidence that the formation they represent once occupied a great extent of this county, from which it has been swept off; but it would be difficult, perhaps, to determine the age of the denudation in relation to that of the trap eruptions. It has occurred to

* Illustrative specimens of all the Traps described were laid on the table, and exhibited during the reading of the Paper.

me, however, that the trappean masses may have formed a line of resistance to the denuding processes; that their hard, unyielding character prescribed the barrier beyond which destruction was not permitted to pass. And this idea finds support in the fact, that the trap accumulations frequently take the character of headlands projecting into the Carboniferous area, just as rocks stand out from the existing sea-shore.

In different localities these traps vary considerably in thickness. At Yeoton, near Crediton, the mass is not more than fifteen feet thick; at Western Town, near Ide, it is about thirty feet; whilst at Pocombe it varies from probably about thirty feet on the western side of the quarry, to upwards of sixty feet on the eastern side, where the excavation has been carried to fully this depth without reaching the bottom of the mass. It is not easy to determine the breadth of these rocks, as the quarries are never worked to their full extent.

In many of the quarries dikes of what, as a matter of convenience, may be called sandstone, traverse the trap in a manner strongly resembling elvan courses. They vary in width from about an inch to seven feet. At Raddon Court blocks of trap are apparently imbedded in them like boulders in a mass of clay. The larger dikes reach the surface, but some of the smaller ones thin out some distance below it, as if the material had been injected from beneath; nevertheless, I incline to the opinion that they have been filled from above, and that the apparently anomalous phenomena are ascribable to pressure. At Budlake, near Killerton Park, this so-called sandstone runs along the south side of the quarry for a distance of sixty feet. Horizontal lines, from less than one inch to fully three inches apart, occur in it, and produce a sort of pseudo-stratification. This case, however, is quite distinct from that previously mentioned as occurring at Rew. At Posbury, a nodule of chalcedony, more than a foot in diameter, may be seen in the middle of one of the dikes. In most cases the dikes and the trap which they traverse are so firmly blended, as to render it much easier to detach a hand specimen containing both kinds of rock, than to sever one from the other. They vary in texture from a comparatively friable, to a compact subcrystalline sandstone, and are invariably lighter in colour, and richer in lime, than the rocks they have invaded. In Stone quarry, near North Tawton, circular white spots, having a dark point in the centre, occur in the dikes, and resemble those so prevalent in the mottled marls between Exmouth and Sidmouth.

In some localities, as at Pocombe in particular, the trap is traversed by veins in so many directions as to form a kind of network. On the whole, perhaps the horizontal is their prevalent direction. Their greatest width is somewhat more than an inch; but in most cases they do not attain to one half of this. They are composed of carbonate of lime in distinct laminæ, and by the contrast between their white colour, and the dark red of the trap, they add much to the beauty of the stone for building purposes.

Joints are very numerous, but they can scarcely be said to have definite directions. Slickensides frequently occur on their faces. At Washfield the joint faces have a reniform crust; and in most localities the joints themselves are filled with a black powder, probably a mixture of the oxides of iron and manganese. A powder of this kind frequently fills the cells of the vesicular traps.

At the well known Pocombe quarry the trap rests on Carboniferous slates, and is covered with Trias. In the Triassic Conglomerate at Exeter Quay are pebbles of vesicular trap, the cavities of which are filled with Zeolite. From their aspect they may have come from Northernhay, or from Pocombe. At Yeoton quarry, near Crediton, there is a very instructive section, in which the trap rests on the Trias; the lower beds of the latter have all the characters of the ordinary New Red Sandstone, but the upper ones have undergone a graduated alteration. At first they are simply harder, but ultimately, when in contact with the igneous rock, they become jaspideous. In this section the Trias contains trap pebbles resembling those of Exeter Quay, already mentioned.

Near Crediton Railway Station there is a section of Triassic Conglomerate, the higher beds of which contain pebbles having all the characters of the Yeoton Trap just described. At Posbury quarry the trap on the eastern side is covered with a fine, apparently stratified, arenaceous rock, which fills a depression in the surface of the igneous mass, but differs in aspect from the New Red Sandstone generally. The lower portion of this arenaceous deposit has been changed, as in the case just mentioned at Yeoton. Near the Haldon Belvidere also the conglomerate has been much hardened where it comes into contact with the trap. At Randiscombe, near West Sandford, where the Triassic Conglomerate was formerly burnt for lime, the trap overlies the Trias, but the latter does not seem to have undergone metamorphosis. The conglomerate contains trappean pebbles unlike the overlying igneous

rock. On the eastern side of the quarry at Stone, near North Tawton, the Trias overlies the trap; and here, too, I found, in the former, a pebble of igneous rock unlike the trap *in situ*.

At Western Town I caused a pit to be dug in the trappean floor of the quarry, and beneath it found a layer of hard sandstone, overlying the ordinary loose conglomerate, containing trap pebbles, which, as at Randiscombe, differed from the trap of the locality. That the conglomerate belonged to the Trias was evidenced by the fact that it contained Beekites, which, as is well known, occur abundantly in the Torbay red cliffs. The bases of the hills at both Western Town and Knowle clearly belong to the Carboniferous system; but whether at the latter locality the Trias is intercalated between it and the overlying trap it is not easy to determine. In a small quarry in the intervening district the Conglomerate has undergone great alteration. In the lane leading down the hill from Knowle towards Idestone the following section presents itself, in apparently unbroken descending order:—1st, Trap; 2nd, Red Conglomerate; 3rd, Vesicular Trap, having cells filled with zeolitic powder and agate (this mass is traversed by a dike similarly to those already described); 4th, Sandstone; lastly, Carboniferous slate. This section is, perhaps, less trustworthy than a vertical one, and, as Mr. Godwin-Austen suggests, may have been produced by a fault; but of which, however, there is no evidence. On the western side of the Raddon Court quarry the red marl overlies the trap. Where the trap crosses from Killerton Park to Budlake quarry it can be seen on the roadside resting on the Red conglomerate and marl beds. Similar appearances present themselves at Yolden and at Silverton Park. The latter section appears to be that mentioned by Conybeare.* The quarry is now a fish-pond.

Chronology of the Feldspathic Traps.—From the foregoing facts it may be inferred that the earliest eruptions of our feldspathic traps occurred between the close of the Carboniferous and the commencement of the Triassic eras, and that later outbursts were of Triassic age. A chronology which, on the whole, harmonizes with that of Conybeare† and of De La Beche.‡ It may not be without interest to observe, that the granites of our county have been shown to belong to the interval between the Carboniferous and Triassic periods.

* "Annals of Philosophy." New Series. Vol. 2nd. Page 162. 1812.
† *Ibid.*
‡ Report of Cornwall, Devonshire, &c. Chapter vii. 1839.

ON

AN ACCUMULATION OF SHELLS WITH HUMAN INDUSTRIAL REMAINS,

FOUND ON A HILL NEAR THE RIVER TEIGN, DEVONSHIRE.

BY WM. PENGELLY, F.R.S., F.G.S., ETC.

AT the meeting of this Association held last year (1864) at Torquay, a paper on a Kitchen-midden on the north-west coast of Cornwall, was read by Mr. Spence Bate. An abstract of this communication, which appeared in the local prints, caught the eye of Mr. William Hearder, of Torquay, who was thereby reminded that about thirty years ago, his father, who then farmed his own estate of Rocombe, in the parish of Stoke-in-Teign-head, directed one of his workmen to make a hedge across a field which occupied the slope of a small hill. Whilst engaged in this work, the workman (William Brooking) disinterred two human skeletons lying very near each other, with their heads towards the east. Immediately beyond them he broke into a large accumulation of shells, about a foot below the surface. Their occurrence in such a place was considered so remarkable, especially when taken in connection with the skeletons, that Mr. Hearder and the Rev. Mr. Gould, rector of the parish, decided to excavate them, in the belief that objects of interest to the antiquary, and perhaps of intrinsic value, might occur amongst them. It was found that the shells, with but little admixture of earth, occupied a sort of trench extending towards the summit of the hill. Numerous fragments of pottery occurred with them, but these, passing as mementoes into the hands of visitors who daily crowded to the spot, are scattered beyond the possibility of recovery. A coin, said to be of copper, and about the size of a farthing, was also dug out, but of this, too, all traces are lost.

The articles discovered not equalling the hopes of the gentlemen who directed the operations, the work was discon-

tinued, and the shells were thrown back into the trench from which they had been taken, but of course not quite in the condition in which they were found. Many of them had unavoidably been much broken, and they were somewhat intermixed with the earth and stones which had previously covered them.

It appears that it had long been noticed that when occupied with a green crop, a distinct and well-defined band, of comparatively dark colour and luxuriant growth, extended from the line of the new hedge towards the highest part of the field, where it inclosed a more or less circular space of about eighteen feet in diameter; in fact, it became a sort of "fairy ring." The excavation just mentioned showed that the position of the shell-trench, so far as it was disclosed, was precisely that of the dark band; and, in the belief that this was more than a mere coincidence, the general opinion was that the shells, by increasing the fertility of the soil, were the cause of the darker hue; and, conversely, that wherever this line was conspicuous, shells existed beneath.

Believing that this accumulation was somewhat akin to a Kitchen-midden, and that it deserved a thorough investigation, Mr. William Hearder mentioned the subject to Mr. Bate, to Mr. Vivian, and to me. It was brought before the Committee of the Torquay Natural History Society, who at once decided to re-open and thoroughly investigate the shell-trench from end to end, for the purpose of ascertaining the exact nature of its contents, and in the hope of being led by it into the fairy ring, which it was thought might prove to be the richest repository of objects of interest. At our first visit the field was found to be occupied with a crop of wheat, but no time was lost in making the needful arrangements; and as soon as the corn was harvested we commenced operations, when we were so fortunate as to secure the services of the workman who, thirty years previously, first discovered and excavated the shells. From its commencement to its close, the investigation was personally superintended by Mr. William Hearder and myself; whilst occasional visits were made by Mr. Vivian, Mr. Sheppard, and other members of the society.

Though we very literally carried out our intention of a complete excavation of the trench, we were not so fortunate as to enter the charmed circle. So far as we could judge, the two have no connection; for though no two persons concurred respecting the exact position of the latter, all were agreed that it was considerably above what proved to be the

[illegible] shells. We dug hither and thither, under the guidance of different persons well acquainted with the field, but failed to discover shells, or any other remains, below the surface of what our guides successively assured us was the precise position of the ring.

Measured in straight lines, the hill at Rocombe is about four miles from Torquay, three from Newton and also from Teignmouth, something more than one from the camp, supposed to be Roman-British, on Milbern Down, and a mile and a-half from the sea, as well as from the right bank of the estuary of the Teign. It consists of red conglomerate rock belonging to the New Red Sandstone system, and rises from the valley at an angle of mean elevation of about 15°: where the acclivity is greatest it is about 28°.

The shells, which occurred at from ten to twelve inches below the surface, occupied a trench somewhat resembling a drain, which was rudely but distinctly cut in the conglomerate. It varied from two and a-half to four and a-half feet wide, and had a tolerably uniform depth of fully four and a-half feet. It commenced on the hill slope at a level of about one hundred and seventy feet above that of a small stream in the valley immediately below, and, with an interval of thirteen feet, continued up the hill nearly in a straight line for a distance of one hundred and sixty feet, where it reached the level of one hundred and forty feet above the stream.

The entire mass of earth and shells, which at each extremity thinned out in both width and depth, may be taken at one hundred and forty-seven feet long, four deep, and three and a-half broad, or upwards of two thousand cubic feet. After making the liberal deduction of twenty-five per cent. for what may be termed extraneous matter, there remain more than fifteen hundred cubic feet of shells, or from fifty to sixty cartloads.

The species found were the oyster, *Ostrea edulis;* mussel, *Mytilus edulis;* limpet, *Patella vulgata;* cockle, *Cardium edule;* periwinkle, *Littorina littorea;* venus, *Tapes decussata;* and snail (three species), *Helix aspersa, H. caperata,* and *H. hortensis.**

A study of the shells brings out the following points:—

1. With the exception, possibly, of the snails, the molluscs are all of edible kinds.

* Dr. Woodward, of the British Museum, to whom I submitted a series of the shells, was so good as to confirm my determination of the species.

2. Since oysters existed in the Teign until a very few years ago, all the marine forms are such as were formerly derivable from the adjacent estuary.

3. Though the large cockle, *Cardium aculeatum*, is abundant in Torbay, and pectens are anything but rare anywhere on the neighbouring coast, they do not occur in the accumulation.

4. None of the shells appear to have been such as are known to conchologists as "dead shells." For example, though many of the valves of the oyster were covered on the exterior with serpulæ, nothing of the kind occurs on their inner surfaces.

The foregoing facts, both positive and negative, suggest that the shells are those of molluscs which had been used as food by people living on or very near the hill at Rocombe, and that they were obtained in the estuary of the Teign at a time when the sea had freer access to it than at present. This, however, would not necessarily take us back to a very remote period, as, according to ancient records, Teignmouth was formerly a considerable haven, when the river was navigable for ships of larger size than at present, and no shifting bar existed at the entrance.

A large number of cockle shells were found with their valves still united and closed. That they had been opened, however, is evident from the fact that fragments of other shells were found within some of them. When cockles are boiled, it is usual, at a suitable stage of the process, to give the vessel containing them a shake, by which the molluscs are summarily ejected from their dwellings; subsequently the empty shells, with valves open, but united, are picked out and conveyed to the nearest modern Kitchen-midden, where many of those which lie on one side are closed by the pressure of the superincumbent accumulation, whilst others not so favourably placed are pressed more widely open, and the valves frequently disunited. In order to their being closed without the disunion of the valves, the shells should be taken to their resting-place before the hinge ligament has had time to stiffen. Applying these facts to the case before us, we seem to have an indication that the early Rocombites boiled their cockles, and at once took the empty shells to the trench in which they were recently found. The oyster valves are always disunited, so that probably the first man who had courage enough to attack a raw oyster lived in pre-Rocombe times.

Though specimens of each of the species occurred in every

part of the mass, the distribution was by no means uniform. For example, for a yard or two cockles would greatly preponderate over the other kinds, but at length give place to oysters; and these in like manner would be succeeded by periwinkles, and so on. The snails were less abundant than the marine forms; nevertheless, they—especially *H. caperata* —were too numerous to allow it to be supposed that their presence was accidental. The individuals of each species had reached maturity; there were no juveniles, such as are constantly met with where, owing to favourable conditions, a colony of snails establish themselves.

Bones of various animals were found mingled with the shells; but, with the exception of a few jaws and teeth, most of them are too fragmentary for identification. Two or three of the specimens appear to have been burnt. With the assistance of Mr. Davies, of the British Museum, I have been able to identify the remains of the ox, sheep, hog, dog, and a bird.

Scattered throughout the mass there were a few fragments of burnt wood or charcoal.

The following human industrial remains were also found: —A bone pin, a fragment of a quern, pieces of pottery and of glass, one small bit of clay pipe, a few iron objects, and a brass ornament. They have all been submitted to Mr. Franks, of the British Museum, through whose kind assistance I am enabled to add to the merely descriptive details of the objects.

The bone pin is 2·1 inches long, and, where thickest—about midway in its length—·15 inches in diameter. Neither its form nor finish betokens a high state of art. It is a common Roman hair-pin.

The fragment of quern, or stone of a hand mill, when complete, was in the shape of a frustum of a cone, having one of its circular ends about twelve, and the other from ten and a half to eleven inches in diameter. A vertical hole through its centre must have been about three inches across. The smaller end was a plane, but the larger symmetrically concave. Its thickness at the circumference was about 3·1 inches, but barely 2·7 inches at the edge of the central aperture. The circumferential arc of the fragment subtends an angle of 51°, hence this remnant is about one-seventh of the entire stone. It appears to have been formed of volcanic rock of coarse texture. It is unquestionably Roman, and was probably brought from Andernach, or some other spot on the Rhine.

The pottery is generally formed of coarse micaceous clays, of various colours. The fragments are obviously portions of a considerable number of different kinds of vessels, some of

which were glazed. A few of the external surfaces are fluted, and on others are drawn one, or more frequently two systems of approximately parallel lines; those of either system are not all equidistant, but they invariably cross those of the other obliquely, so as to cover the surface with a series of lozenge-shaped figures, which, on different fragments, vary considerably in size. One of the specimens, composed of a fine, dull, light yellowish-red clay, appears to be a portion of a small two-handled jar. Nothing of corresponding form exists in the British Museum. There is one fragment of what appears to be a tile or thin brick, apparently composed of the same clay as the jar just mentioned.

The fragment of clay pipe has every appearance of a bit of a common modern tobacco pipe, broken at the junction of the stem and bowl.

The pieces of glass are two in number, and are clearly adjacent portions of one and the same vessel, which must have closely resembled a common wine bottle.

The iron articles are a broken large-headed nail, about two inches long; a bar or rod, upwards of four inches long, and something more than a quarter of an inch thick, having the appearance of a broken gimlet; and a tube or ring an inch and a half long, half an inch in diameter, and much resembling the common adornment of a pig's snout.

The brass ornament is an unclosed ring, probably an armlet, measuring 7·3 inches in circumference; its inner surface is flat through the entire length, but on the exterior it is flattened only within an inch and three quarters of each end, the remainder being rounded. At the curvilineal portion it is ·2 inch thick and half an inch broad; at the ends the thickness is scarcely one-fifteenth of an inch, whilst the breadth is slightly increased. Its weight is about 1·3 ounces avoirdupois. Along the exterior curvilineal surface it is ornamented with five small indentations at irregular distances, and there appear to be three pairs of similar marks on each of the flattened ends.

It must be admitted that the bit of clay pipe, as well as the pieces of glass and iron, have a decidedly modern aspect; and when it is remembered that thirty years ago a part of the accumulation was dug up and thrown back again, it is to be expected that the collection should contain a few anachronisms. Thus, though there is no reason to suppose that any of the objects belong to a pre-iron age, it is by no means improbable that one of the articles is really a portion of a nose-ring, or, in the language of the south-western counties,

a "spuke" which, not many years ago, was lost by a pig feeding on the spot; that another is a fragment of a gimlet broken and thrown away or lost by some artizan, who had used it in the field in repairing a plough or some other farming implement; and that these, together with the nail, were thrown in with the shells when re-interred. The glass may be fragments of a modern bottle in which a labourer was wont to take his daily beverage with him, or which was used for a corresponding purpose by one of the numerous visitors who watched the first excavation. And, in like manner, the bit of clay pipe is probably a relic of a modern tobacco pipe.

With the omission of the articles just named, and probably such of the fragments of pottery as are glazed, which are believed to belong to the mediæval or a more modern period, the collection is without doubt Anglo-Roman; the armlet, the hair pin, the unglazed pottery, and the quern are alike conclusive on this point. It may be less easy, perhaps, to say why the early Rocombe folk so decidedly preferred a subterranean to the ordinary sub-aërial Kitchen-midden as to be at the pains of digging a trench for its reception. The idea that the trench was made for the purpose of draining the field is entirely without foundation. The nature of the subsoil, as well as the configuration of the country, renders such a hypothesis altogether untenable.

GOLD.

BY W. COTTON.

THERE are few subjects in our social and political economy so important, and about which there appears at the same time to be such little knowledge and interest with the public, as Gold. As the subject does not appear to have been previously brought before the Association, and as it is a legitimate one for its notice, I have ventured to jot down a few rough notes—which, however, cannot perhaps lay claim to much novelty or originality—with a view, chiefly, to the possibility of eliciting a more elaborate treatise from abler hands on some future occasion.

It is the fashion with our political economists and leading financiers, in discussing the marvellous growth of the commerce of this kingdom, to attribute the same entirely to the effects of fiscal regulations tending to Free Trade. The possibility of any other element having been at work to contribute in any degree to this prosperity, is usually scouted, and Gold comes in for its due share of obloquy.

Without in the slightest degree detracting from the beneficial action of Free Trade—which all must allow has been *mainly* the cause of the vast increase of trade—there can be no doubt that the production of Gold since 1848, in quantities which have never before been approached, must have had a powerful influence. Indeed, I would go further, and assert that the trade of the country could not have attained its present dimensions legitimately, without the additional capital brought to bear upon it by the production of large quantities of Gold: in other words, that the savings of the nation, in the few years that the great increase of its trade has been so marked, would not, without some such aid as Gold affords, have added sufficient to its capital as to produce such results.

In the year 1842, Sir Robert Peel first began the fiscal revolution, and in 1845 all export duties were abolished. Had these reforms been commenced ten years earlier, we should have been able better to judge of the relative effects of Free Trade and Gold. As it is, we have but a narrow

margin, and that somewhat clogged with exceptional circumstances.

In 1815, our trade, as shewn by the declared value of the Exports, amounted to 51 millions; and although mostly a time of peace up to the year 1844, they showed no increase. Indeed, the falling off in the worst year reached 20 millions, falling to 31½ millions, and in 1842, the first year of the new policy, they actually stood at 4 millions below that of 1815. In 1844, there was an improvement to 58 millions, and in 1845 the removal of the export duties appeared to have an immediate effect, for the value of the trade stood at 60 millions.

The three following years disturb our calculations, on account of the Railway Mania, the Monetary Crisis, and political disturbances. The figures show a decline in 1846 to 57 millions, in 1847 to 58 millions, and in 1848 to 52 millions.*

In 1848, the first discoveries of new gold-fields were made in California, and the precious metal, by way of America (with which country we had large transactions), must soon have found its way to the chief markets of the world.

In 1849, our Exports had increased to 63 millions, being an addition of 11 millions to the previous year, of which 4 millions was an increased trade with America.

From 1849 to 1852 we may call the Californian Gold years, and in that time our Exports increased 25 millions in amount. In 1851 were made the wonderful discoveries in Australia; and by 1853 we were probably experiencing their full benefit. We find in that year, that the value of our trade had increased 20 millions over the previous year, and for the five golden years, from 1849, by no less than 45 millions, being only 7 millions less than the *total* Exports of 1848, viz., 52 millions.

The whole amount of Gold raised in South America and Mexico during the 45 years—1804 to 1848—was 148 millions, or an average of 3¼ millions per annum. As I have before said, the greater portion of that period was a time of peace, and our trade languished. Making every allowance, therefore, for commercial restrictions, which undoubtedly would have the *principal* depressing effect, may we not infer that the production of Gold up to 1848 was no more than sufficient to supply the currency of the world, and left nothing to be added to its capital? In the 11 years—1849 to

* It is a noteworthy fact, that the value of our Exports in 1839 exceeded by half-a-million those of 1848—three years after all Export duties were abolished.

1859—was produced, in California and Australia, Gold to the value of 260 millions, or an average of nearly 24 millions per annum; and we may further safely infer, that considerably more than sufficient being produced to supply currency, the excess has been applied to capital, and to some extent conduced to the extraordinary development of our commerce. The declared value of our Export trade, taking the average of the years

1851	to	1855	was	88½	millions
1856	„	1860	„	124	„
1861	„	1863	„	131⅓	„
1864			„	160	„

To recapitulate, in 1848, the year of the first Gold discoveries, our trade stood at 52 millions, and last year they reached the enormous total of 160 millions.

There is no reason to apprehend a falling off in the *production* of Gold. On the contrary, new appliances being brought to bear upon mining operations, and new fields opened up, there is every probability of the supply being increased. The importations to this country have, however, been somewhat below the average during the last four or five years, and it may be accounted for from the fact of the stream of Gold being diverted temporarily, to some extent, *from* this country. The Peninsular and Oriental Company's ships, for instance, alone took from Australia to India and China, in 1861, two-and-a-half millions, in 1862, three millions, and in 1863, four millions.

An interesting discussion took place last year, as to whether Gold, in consequence of the great addition to the stock of the world, has not suffered a depreciation in value. The enquiry is surrounded with difficulties in consequence of the impossibility of fixing with certainty a relative standard of value. The prices of all commodities relatively with Gold, by which alone we can judge as to whether Gold has or has not depreciated, are subject, more or less, to certain influences. Real property is subject to fluctuation in value from the circumstance of locality, from the influence of railways, and other causes. Wages, which might be considered a safe test, are influenced by emigration, strikes, or an exceptional demand for labour, owing to public works, &c. All will allow, I think, that notwithstanding the reduction in price of certain luxuries, owing to the remission of duties and imposts to the amount of 16 millions in the last six years, the general cost of living has increased during the last 15 years. This has

been felt to be the case more particularly in Paris, Italy, and other parts of Europe; and at the time of an extensive importation of Gold into India in payment for cotton during the American War, there came from that country an universal burst of complaint concerning the high price of every necessary of life. Whether Gold has or has not depreciated, such is now the facility of intercourse between the great markets of the world, that any effect must be spread over a large area, and perhaps lessened as new channels for disposing of it are opened up. In view, however, of the vast quantities of Gold that will probably be added to the General Stock for some years to come, in making arrangements for deferred annuities or payments, it would be well to have an eye to the contingency of a considerable depreciation.

It has by some been considered that a depreciation in the value of Gold would cause a corresponding appreciation in the value of Silver. Silver, not being the standard of value in this country, is subject to fluctuations in price, principally from the effect of the exchanges with countries having a Silver currency, and the demand for export to the East. The effect of a continued large production of Gold will probably lead to the general adoption of that metal as a currency. France has already done so in part, and India is moving in the same direction. As to India, notwithstanding that our importation of cotton increased from 38 millions in 1861 to over 70 millions in 1864, the export of *Silver* to the East gradually declined from 14 millions in 1859 to 6 millions in 1864. At the same time, the importation of Silver from the countries producing that metal increased from 3¼ millions in 1859 to 7 millions in 1864. The price of bar Silver in the former year averaged 5*s.* 2*d.* an ounce, while the latest quotation I have seen this year is 5*s.* 0¼*d.* an ounce, the lowest price it has reached, taking the average, since 1852. Should Holland and Hamburg, and those countries whose currency is now of Silver, follow the example of France, and should the introduction of a Gold currency into India prove successful, the use of Silver to that extent will be superseded, and we may anticipate a depreciation in value instead of an appreciation, as apprehended. If this, as is probable, should lead to its greater adoption in the arts and manufactures, and dispose of some of the imitations now so much in vogue, it would be a change by no means to be regretted.

In conclusion, whatever difference of opinion may exist as to the effect of these precious metals, there can be but one opinion as to the immense benefits they confer upon the

world when their utility is developed by an honourable and intelligent nation.

It may be asked, indeed, what Spain has gained by the countless millions of treasure that flowed to her coffers from the prolific mines of Peru and Mexico. Spain knew not how to profit by the advantages thrown in her way, and she now exhibits the pitiable spectacle of a bankrupt treasury, and a civilization behind all the rest of Europe. The restless energy, the intelligence, and indomitable industry of this country, greedily hails this stream of wealth to feed that spirit of enterprize which manifests itself in our shipping, our manufactures, and our commerce; which transforms the jungles of India into a smiling tea-garden, to compete—and successfully, too—with the native and long-established trade of an immense empire; and aspires to consummate an undertaking more wonderful than was ever conceived in the most fabulous of romances,—the uniting of the two hemispheres with a chain of communication, which, let us hope, will be a perpetual bond of sympathy between two kindred nations, as it will be a giant step in the march of civilization.

THE ARTISTIC TREATMENT OF DEVONSHIRE BUILDING MATERIALS.

BY R. APPLETON, F.I.B.A.

Mr. President, and Ladies and Gentlemen of the Devonshire Association,—I make no apologies for introducing the subject of this paper to your notice, as it seems to me to come fairly within the cognizance of our Association as a matter of *social science* and every day art.

In the state of society in which we live, it behoves each, not to live *only* for himself, but even in such matters as the building of our dwellings, to have *some* regard to the enjoyment of everyone who may only chance to be mere passers by. In a county, too, so rich in beautiful building materials, there seems to be a certain amount of responsibility resting upon all who have to do with them, to *use* (in every sense of the word), and not *abuse* them. "A thing of beauty is a joy for ever;" and the converse is equally true.

Under the name of the building materials of Devonshire will be included the *granites*, *limestones*, sandstones, trappean rocks, conglomerates, slates, flints, brick earth, and terra-cotta, including, if you will, the now almost extinct *cob*. The time allotted to our papers will allow but a mere glance at some of them.

The *granite* of Devonshire, as well as Cornwall, has long been held in high repute, and has been selected in preference to others in the construction of many of the most modern edifices; and for the purpose of obtaining it, some years since a tramway (which is itself of granite) was constructed, as many here doubtless are aware, from the Hay Tor district to the Stover Canal, near Bovey Tracey. The quality of the stone varies greatly, from the loose disintegrated surface boulders, so well known by the lovers of the picturesque beauties of our county, to the fine hard, compact grey stone generally used for building purposes. Nature seems to indicate that the right and proper treatment of *granite* is

FIG. 1.

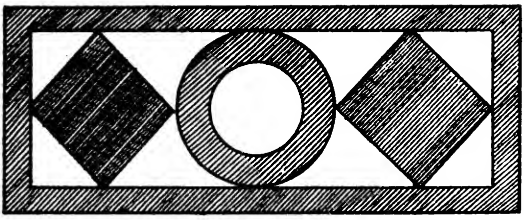


FIG. 2.

boldness and *size*. The plain and almost cyclopian walls which one meets with in the granite districts, always give a feeling of pleasure, from the manifest appropriateness of their treatment; while *finely-tooled delicate* mouldings frequently *fail* to satisfy, and one feels that the great feature of the stone is gone: if wrought, the treatment must be *simple, bold, large;* if otherwise, the labour bestowed will be lost; at the same time, it cannot be denied that as a *decorative* material, granite must not altogether be lost sight of, but still the *same* treatment must be observed: *plain*, polished surfaces in masses, such as *large*, bold *columns* or panels, form very pleasing features, but no delicately carved capitals or fine *inlaid* work are admissible; all that must be left for the sandstones, marbles, and terra-cotta. Our Devonshire granite seems to require contrast with material of a *warmer* tint when used for *decoration*, and forms a charming foil to the warmer tints found in the same materials of Scotland.

Much that has been said of granite applies equally to *limestone*, it *always* looks well in bold, big masses, and when so used, needs but little assistance from man; leave it in all its glory of rugged beauty and gorgeous colouring, each excrescence in sunlight will cast a shadow, and cause a play of light more beautiful than the most finished mouldings; and I may here observe in passing, that in all dark materials, mouldings and carvings are lost—you cannot accomplish the objects aimed at by their use; the shadows, and light, and shade are, so to speak, *absorbed* in the material itself: and the same remark applies somewhat to *polished* mouldings and carvings in even *light-coloured* materials, especially if *veined* or *mottled*, the *reflected* light in this case acting very similarly to the dark material in the former. Unlike granite, limestone may be used either in large or small blocks with equal advantage; and this is doubtless largely attributable to the great variety of colour and tone in the material: the beautiful *mottling* and play of light caused by the unevenness of surface are not disturbed with being broken up by small pieces, but seem to be assisted thereby, and for *polished work* gives the glory and loveliness so peculiar to our Devonshire marbles, a few specimens of which were exhibited last evening at the conversazione; what can be more beautiful than some of these marbles? why need we go to Italy for materials when we have so large a variety of our own at Ipplepen, Ogwell, Petit Tor, Chudleigh, and Plymouth?

The *marketable* value of these marbles for decorative purposes is justly daily increasing; there is scarcely a modern

church of any pretensions within 500 miles of Exeter, in which Devonshire marble is not introduced, and it is frequently exported to other countries and our colonies; it is equally applicable when used as *monoliths*, or *built* up in blocks of parti-coloured stones, arch voussoirs, or the veneered inlay of mosaic and Florentine work; let those who are not conversant with it go to St. Mary Church, Luscombe Park, or St. John's, Torquay.

I venture here to suggest another mode of treatment particularly appropriate to some of our Devonshire marbles, from the fact of the great difference of colour in their polished and unpolished surfaces, this (fig. 1) is a specimen which I have had prepared to illustrate the idea; the effect is produced, as you will observe, by polishing the desired ornamentation or pattern, *leaving the ground* in a rough condition: the expense of *inlaying* is saved, and yet much of the effect obtained. The relative *cost* for large works is as about *eight to fourteen*. I am free to confess that the treatment is only suitable to dark materials, but it is those which are generally selected for decorative purposes; it can be applied with advantage wherever dark marbles are used, whether for shafts, panels, or otherwise.

The *sandstones* can be used in almost any way, as they do not suffer in *tone* by workmanship, but nature seems to have indicated that the monotony of colour demands *contrast*, by furnishing us, in the same quarries, stones of different tints.

Our ancestors seem frequently to have felt this, and therefore adopted the expedient (lately renewed with such furor) of introducing bands of different coloured materials and voussoirs of alternating tints in their arches. Some of our modern buildings have, however, been carried out (by John Bull, in his usual riding to death principle) to such an outrageous extent in this way, as to call forth the appellation of "*Streaky Bacon*" for this style of building: and one notable church in the North of England is commonly called in the neighbourhood by the very unecclesiastic name of "*The Holy Zebra.*"

Many *good ancient* examples of this alternated work exist in this county; the Exonians have lately brought to light one, by stripping off the plaster from the staircase turret of the church in the Cathedral yard, another good example may be seen at Paignton, in the Saxon doorway at the west end, under the tower. (Fig. 2.)

When dealing with the *Conglomerates* we are fortunately *compelled* to follow nature, and leave the stone in all its beauty

of ruggedness; for the difficulty and expense of dressing it generally obliges the selection of a different stone, where tooled work is required; but in *rough, bold, massive* treatment, such as that usually found in engineering works, no material can be more appropriate. It is occasionally met with tooled into *comparatively smooth* surfaces; but the value of the stone, in point of appearance, is undoubtedly marred thereby, and what perhaps is worse still, its durability is greatly diminished by the process. And here I cannot help remarking, that though in a *constructive* point of view the placing of stones on their *edges* or transversely to their natural *bed or stratification* is sound, the effect upon the stone itself is *undoubtedly* injurious; disintegration will set in far more rapidly than if the stone is placed on its natural bed, and what is more to the point of this paper, it is æsthetically wrong; better, if possible, select a different stone, where *stratification* is not strongly marked, than go contrary to the teachings of nature.

The *Trap* rocks are abundant in many parts of the county, and yield excellent building materials; being mostly exceedingly hard and compact, they will bear a large amount of fine dressing, and are not injured in appearance by it. I have only to refer you to such of the *old* buildings (and a few *new*) in Exeter as are not plastered, and a doorway in the church of this town, to remind you of the stone obtained in this county, which frequently exhibits a considerable amount of beautiful marking, and an exceedingly pleasing surface caused by the honeycombing.

The *green trap stones* are but little used, except those which are obtained in thin pieces, as found in the neighbourhood of the Dart, near Dartmouth, where the walling built with it, except for rough purposes, is usually plastered. The green trap stone of Black Head, near Ansty's Cove, is an exceedingly compact, close-grained stone, and would doubtless make a valuable addition to our inlaid work.

The admixture of stone of a different colour with the trappean rock is always desirable, as the *general tone* is rather too heavy and monotonous to be pleasing. The limestones may be used with advantage, and dressings of the Ham Hill-stone oolite (a deep buff), or Bath stone, give great life and variety. The best proof of the durability of the trap stones is the condition of the work of many of the old county buildings, instance Rougemont Castle, in which many of the stones are as perfect as when placed there.

I must, however, pass over much that deserves notice,

especially the flints and slates, to call the attention of the Association to the recently discovered natural *terra cotta* of this county. Since the last meeting of this society a deposit of exceedingly fine terra cotta has been found at Watcombe, situated in a valley close to the sea, at the lower extremity of a water shed, and about a mile and a half in length, enclosed mainly by conglomerate rocks, it appears to be the subsidence of the finer detritus. The proprietor of the land, Mr. Allen, has had borings taken, and by his kindness I am enabled to exhibit specimens of the clay obtained at different depths. Mr. Allen, who is a good judge of fictile work, has had several specimens of ware manufactured from the clay, and for beauty of colour and fineness of grain, as well as the perfection of the material for all such purposes, it cannot be surpassed even by the Italian clays. A careful analysis is being prepared by Dr. Percy, of the Jermyn Street Museum, and when completed will doubtless afford means of judging of its *commercial* value.*

* Since the delivery of the foregoing, Dr. Percy's analyses of the terra-cotta has been completed, and, by the courtesy of Mr. Allen, I am enabled to add it to this Paper.

COPY OF DR. PERCY'S REPORT.

"*Metallurgical Laboratory*, 28, *Jermyn Street*,
"*4th July*, 1865.

"SIR,—I have pleasure in forwarding the results of the examination of the Red Clay sent by Mr. Allen.

"The sample of Clay, in its moist state, as received here, contained 21·42 per cent. of Hygroscopic water. The analysis of the air-dried clay gave as follows:—

COMPOSITION PER CENT.	
Silica	57·83
Alumina	20.55
Peroxide of Iron	7.75
Oxide of Manganese	traces
Lime	1·68
Magnesia	0·97
Potash	3·87
Soda	0·56
Carbonic Acid	0·90
Phosphoric Acid	traces
Organic Matter (small quantity) / Combined Water	4·39
Hygroscopic Water	2·13
	100·63

"It was also examined for Sulphur and Chlorine, but none was found.

"The Silica (about 21·21 per cent.), as is usual in clays, is partly in combination with the Alumina, the remainder being present as fine sand. The Hygroscopic Water would be expelled at about 212° F. The plastic

Mr. Thaed is also engaged in trying its plastic properties for sculpture. For architectural purposes the use of terra cotta are too numerous to detail. The extent of the deposit is not at present definitely ascertained, but, as far as it can be judged of, it promises to be a most valuable addition to the economic geology of our county. In addition to its value as a plastic material for the manufacture of every article, from the ordinary building brick (for which the top beds furnish exceedingly good material) to delicate ornamental vases or enamels and tesseræ, it promises to yield *dyes* of great value. The various tints of umber and ochre may readily be obtained, and a deep rich liquid *blue* has been extracted. When overburnt, a very hard semi-vitreous surface, of a rich moroon tint, is produced, exceedingly valuable for many building purposes.

While on the subject of brick, one must not omit to mention the admirable material obtained from the refuse of the *pottery clay*. Its value for architectural purposes, in contrast with the ordinary red clays, is gradually being acknowledged, and its fire-proof properties are already largely known and valued throughout the West of England, and by many London consumers.

In conclusion, it seems a matter of astonishment, that in a county so rich in building materials of the greatest variety and beauty, that the practice should exist of concealing them with *stucco* and plaster; one can only deplore the evil, and use every effort and opportunity possible for remedying it. I can fancy some of my Torquay friends whispering, "Physician, heal thyself;" why are *you* a party so often to the sin you condemn in others? My friends, I can only say with Shakespeare's apothecary, "*My poverty, but not my will consents.*"

nature of the clay depends upon the combined water (*i. e.*, water in chemical combination with the ingredients of the clay); this is expelled on firing. As the clay is readily fusible into a black glass at a high temperature from the presence of peroxide of iron, lime, &c., it renders it unfit for purposes for which fire-clays are applicable. The clay appears to work up well, and when fired at a lower temperature has a red colour, and might be used for making terra-cotta and certain varieties of pottery. Specimens of the fired clay have been forwarded. As the amount of Alkalies (Potash and Soda) appears to be somewhat large, three separate estimations were made, which closely agree.

"I am, Sir,
"For Dr. Percy,
"Yours obediently,
"RICHARD SMITH."

ON THE

FLORA OF THE NEIGHBOURHOOD OF TIVERTON.

BY FRED. MACKENZIE, M.R.C.S.

I SHOULD have accepted the honour proposed to me, of contributing a paper to the proceedings of this learned society, with very great diffidence, if its subject had been one involving a discussion on the progress of scientific Botany, necessarily including the recent development of the physiological wonders of Polymorphism; for I should have considered it presumptuous to have addressed those far more conversant than myself with such details. But having been simply required to furnish, for the information of members, some mere matters of fact as to the distribution of the Flora of this neighbourhood, which can hardly challenge even friendly criticism, I have felt that it would be selfish and uncourteous to the Botanists of this society to withhold the results of my observation.

And I should not proceed to fulfil this agreeable task, without first acknowledging my thankfulness for the circumstances under which, instead of the weariness of pursuing my avocations in the turmoil of a large city, uncheered by even a trace of vegetation, I have been enabled, from the necessity of passing daily among the hills, the valleys, and the hedgerows of this beautiful county, peacefully to cultivate some branches of natural history even during the hours of ordinary toil.

I must at once admit, that I cannot pretend that this district possesses great resources of botanical interest. We have not the varied ranges of climate, nor the varieties of geological formation, which indicate to the practised botanist the probable presence of a rich and diversified Flora.

The natural features of the country around us are certainly sufficiently varied, comprising something more than mere undulations. We have in abundance the precipitous hills characteristic of Devonshire, and in some instances picturesque cliffs rising 500 or 600 feet above the banks of the

Exe, or probably 700 or 800 feet above the level of the sea. The valleys of the Exe and Lowman afford a fair harvest to the collector; and until lately the bogs of the district have been sources of considerable interest, although the progress of cultivation has within my recollection greatly diminished these resources of the locality, very much, I hope, to the benefit of the agriculturist, but at the cost of mortification and disappointment to the naturalist.

The soil which covers the red sandstone in the eastern part of the large parish of Tiverton is fertile, and in some instances rich, while that in the northern and western division, which overlies the carbonaceous rocks belonging to the North Devon series, is a poor and comparatively infertile clay. I have not observed that any special botanical interest attaches to the neighbourhood of some extinct volcanoes which appear around us. We have limestone within a few miles, in which I have found only one plant of any rarity, *Cistopteris fragilis*, though I am assured it also possesses *Helleborus fœtidus.*

In attempting to enumerate the plants of special interest (I have, of course, avoided those of general distribution), I must not be presumed to imply that they are elsewhere *rare*, although some of them are, I think, not common in other parts of Devon; but I have rather proposed to mention such as are the less common and more thinly distributed in our own district. I must crave your indulgence, therefore, if, in intending to give a general view of them, I have included some which do not appear to you to possess a claim to your notice.

Following the arrangement of the Natural Orders in Professor Lindley's Synopsis, I have only to mention, in Ranunculaceæ, *R. Sceleratus*, for which I only know one habitat, and *Aquilegia vulgaris*, equally scarce. Among Papaveraceæ, the greater *Celandine*, which is generally assigned to the chalk districts. In Fumariaceæ, *Corydalis claviculata*, thinly distributed on the higher grounds, both in woods and by the road-sides. In Droseraceæ, *D. Rotundifolia.* Among a large series of Hypericineæ, *H. humifusum* and *Androsæmum officinale.* In Caryophylleæ, the handsome *Saponaria officinalis*, for which I only know of two localities. In the order Lineæ, I have found *L. usitatissimum* in fields where flax had not been cultivated, and *L. catharticum.* We are rather rich in Geranaceæ, having, among others, *G. lucidum*, *molle*, *pusillum*, and *Columbinum.* In Oxalideæ, *O. corniculata* I have only once found, and that near enough to a farm-house to create the suspicion that it may formerly have been culti-

vated there as a garden flower. Among Crassulaceæ we have *Sedum reflexum* and *S. Telephium*. In Saxifrageæ, *Chrysosplenium Oppositifolium*, marvellously enriching our moist banks in spring, and at the same season the charming, delicate *Adoxa moschatellina*. In Salicareæ we have *Peplis portula* and *Lythrum Salicaria*, rendered an object of new interest by the researches of Darwin and Scott, on its fructification. On the banks of the Grand Western Canal is found *Genista Anglica*, the only interesting member of the large Order of Leguminosæ. With regard to Rósaceæ, I think I have nothing to record, except that *Alchemilla vulgaris* grows also on the banks of the Canal—an unusual locality for it—and that the wild Cherry is found in some abundance in the western part of this parish, and the Bullace in the same direction more sparely. We had, a few years ago, *Sanguisorba officinalis*, which I fear we have lost by drainage. The only *genera* in Umbelliferæ to which I shall refer, are *Smyrnium olusatrum*, on the road between Halberton and Sampford Peverell, *Sanicula Europea*, *Hydrocotyle vulgaris*, and *Œnanthe pimpinelloides*. In Vaccineæ, *V. myrtillus*, the whortleberry, a very popular fruit among Devonians, is found in the extreme northern part of this parish, and more abundantly in the still more northern parish of Stoodleigh. Campanulaceæ: *C. hederacea* is still to be found in our few remaining bogs. Dipsaceæ: *D. pilosus* has one habitat—Bickleigh, a southern parish. From the important Order Compositæ, I shall only select *Erigeron acre* (not given in the "Flora Devoniensis"), an elegant little plant found only on Rock Hill, Halberton, *Conyza squarrosa*, *Bidens tripartita* and *B. cernua*, and *Trogopogon pratense*, which last is very rare here. Convolvolacæ yields *Cuscuta Europea*. Apocyneæ affords *Vinca minor* in great beauty and occasional profusion. Among Primulaceæ, we have *Lysimachia vulgaris*, *L. nemorum*, and *L. nummularia*, and *Anagallis tenella* in our bogs. In the same situation we have *Pinguicula lusitanica*, of the next Order. In Scrophularineæ I shall only mention *Sibthorpia Europea*, pointed out to me in two situations by Miss Gray, of Exeter. In Orobancheæ, *O. minor*.

The interesting Labiatæ would tempt me to offer many examples, but I shall confine myself to the enumeration merely of *Lycopus Europea*, *Mellitis melissophyllum*, a botanist's treasure, *Lamium galeobdolon*, *Leonurus cardiaca*, and *Scutellaria major* and *minor*, the former very infrequent, the latter not uncommon.

Among Polygoneæ, *P. bistorta* is, I think, lost to us; but

there is a fine clump of it very near the Tiverton Junction. Resedaceæ. *R. luteola* is found in the limestone rocks at Westleigh.

Among the less common Orchids, I have found *Spiranthes autumnalis*, *Listera ovata*, *Epipactis latifolia*, and *Habenaria bifolia* (Butterfly Orchis), very fine. To this list I will merely add that the snowdrop luxuriates in the valley between Butterleigh and Bickleigh, the *Bog Asphodel* is found on Bampton Down, and *Butomus umbellatus* at Hele, close by the Station of the Bristol and Exeter Railway.

I have only time briefly to enumerate the Ferns of the district, which, though existing in wonderful profusion, are only in a few instances rare. They are *Polypodium vulgare*, with several irregularities, or, as they are called, "sports," *Cystopteris fragilis*, *Polystichum aculeatum*, *P. A. var. lobatum*, and *P. A. var. lonchitidioides*, *P. angulare*, *P. ang. var. grandidens*, *Lastrea oreopteris*, *L. filix mas*, *L. filix mas incisa*, *L. spinulosa*, *L. dilatata*, *L. dilatata var. dumetorum*, *L. fœnicesii*, *Athyrium filix fœmina*, *Asplenium adiantum nigrum*, *A. trichomanes*, *A. trichomanes ramosum*, *Ceterach officinarum*, *Scolopendrium vulgare*, with varieties, *Blechnum boreale*, and *Pteris aquilina*.

Having thus, at short notice, and very imperfectly, attempted a sketch of a few plants of interest found here, I have only to add, that it will give me pleasure to furnish more extended information to any members of this society who may wish for it.

ON THE

CRYSTALLIZATION OF FELSPAR IN GRANITE.

BY R. PARFITT, M.E.S.

THE subject of the crystallization of felspar in granite, and its mode and direction of the long axis of the crystals, suggested itself to me some time ago when studying some large slabs of granite. These were of different kinds or varieties; but I believe they were brought from Dartmoor. In studying their composition, and the arrangement of their constituents, I was forcibly struck with the large felspathic crystals having apparently nearly all one direction. This led me to investigate the subject further, and, as I considered it a new one, I wrote to Mr. Ormerod, of Chagford, stating that I had an "idea," if he would kindly assist me in working it out, and to this he readily acceded. Mr. Ormerod very kindly took his compass into the moor, and investigated the subject for me over five miles of district, the result of which I will give you. Thus, in Rushford woods the direction of the long axis is N.W. by N., the hill south of Providence Chapel E. by N. to N.N.E., and near the same chapel their direction is N.N.W. On Shelstone Tor, N.N.W.; Turn to Ash, in Throwleigh, N.W. by N.; John Hooper's Quarry, E. by N.; and at Lower Morchington their direction is N.N.E. Four observations taken on Mill Hill, and from parallel lines of granite, the lines are divided by partings of five yards, or 21 feet, across, and the result of these observations are: 1st, N.N.W.; 2nd, E.N.E.; 3rd, N.N.W.; 4th, N.N.E. On four of the Tors on Meldon their direction is from N.N.W. to W. by N., in some places irregular.* Now, the result of these twelve observations, and, as I before said, they extend over five miles of rock and moor, the prevailing direction is N.N.W. and S.S.E. This, then, I think, would settle the point that this mass of granite was upheaved simultaneously by one gigantic force. And I would infer from this that it was in a cold and hard-

* These observations were reduced to true North.

ened state, the same as we now see it, at the time of its protrusion through the superincumbent strata; we therefore know nothing of the force that was exerted to lift it to its present position; it may have been some form of gas, or steam, or there may be a volcanic bed beneath the granitic mass.

The next question is, under what condition was the granite when these crystals were formed, and what force was exerted to give this peculiar direction to the crystallizing felspar?

First, then, the granite must have been in a thoroughly melted and fluid state, the molecules of felspar and other constituents thoroughly incorporated, and that this mass must have been held in this fluid condition for a very long period to allow the crystallization to be carried on with a degree of uniformity, such as the crystals of felspar now assume, by some agent exerting an influence over the molecules of felspathic matter. It must have been thoroughly fluid, I consider—not pasty, as some suppose—to allow of the molecules or atoms of felspathic matter to traverse the medium in which they were held in suspension. I think a proof of this is, that the large granitic mass was a long time in cooling; that where the mass has been injected into fissures in superincumbent or adjacent rocks, the veins assume a different appearance. Thus, Sir C. Lyell has given several examples of this. Take one in the neighbouring county, Cornwall, as an example. In this "the main body of the granite is of a porphyritic appearance, with large crystals of felspar; but in the veins it is fine-grained, and without these large crystals," and has more of a confused appearance than the principal mass. From this I infer that the cooling process was more rapid than the agent, whatever that might be, could act or make an impression upon it? Now, whether granite or felspar will crystallize under the immense pressure that it is generally supposed to have been, is to me an open question. Some minerals crystallize only as evaporation takes place, others again will crystallize in fluid; but whether either of these varieties would be the same under other circumstances remains to be proved.

We now come to the agent or force that exerted its influence over the molecules of matter as crystallization was going on. This I conceive was the electric current of the earth. The reason, I suppose, is this,—it is the peculiar direction of the felspathic crystals. That electricity does exert and facilitate crystallization, was fully proved by the late Andrew Crosse, Esq., and the more slowly and regularly the process of cooling is allowed to proceed, the larger and

more regular are the crystals (Miller). The peculiar direction of the long axis of these crystals, varying as they do so many degrees west of north, and so many degrees east of north, would, I think, point to an agent such as electricity. You will, of course, understand that I am only speaking of the north polar current, and not of the curious and varying lines in other parts of the earth's surface.

With these few remarks I would earnestly commend this to me interesting subject to your special notice, and I hope that any of the members of the Association who may happen to reside in the granite district would carry these observations further. I should be very pleased to hear that investigations of this kind were also prosecuted in the North of England and Scotland, in districts where the granite is apparently *in situ*.

SOME REMARKS ON THE COST OF THE LIGHT FROM MAGNESIUM, AS COMPARED WITH OTHER SOURCES OF ILLUMINATION, WITH AN ACCOUNT OF SOME NEW INFLAMMABLE AND EXPLOSIVE COMPOUNDS OF MAGNESIUM.

BY J. N. HEARDER, ELECTRICIAN, PLYMOUTH.

THE extraordinary light developed during the combustion of a very insignificant portion of magnesium wire cannot have failed to strike all who have witnessed it with wonder. Dr. Letheby determined that a couple of small wires, of $\frac{1}{100}$th of an inch in diameter, twisted together, and burning at the rate of 2·4 grains per minute, gave the light of no less than 69 standard spermaceti candles, such as are used in photo-metric experiments.

When we reflect on the difference in the quantities of material consumed in each case, as compared with the amount of light given, the question naturally arises, Is there no possibility of rendering practically available a light so superior in intensity, capable of being produced in so small a compass, and with such insignificant means? Contrivances have been introduced for burning magnesium wire, with some approximation to regularity, by uncoiling the wire previously wound upon a bobbin just at the rate at which it is consumed, and to a certain extent this has been successful; but the great point which decides the practicability of this, as well as all other new applications of science, is the question of expense. Until lately the metal magnesium was extremely expensive; when first introduced, magnesium wire was sold, it is said, at a guinea an inch; improvements in its manufacture, and a demand which rapidly increased as its properties became known, soon brought it down to a few shillings, and ultimately to a single shilling *per yard*, or a *guinea an ounce*. This, however, was under a mode of manufacture principally experimental and confined to the Laboratory.

At this price it was computed by various experimentalists,

that the cost of the light from magnesium, as compared with sperm candles, was nearly as 2 to 1. 2½ ounces of magnesium, value about 52s., giving as much light as 26s. worth of sperm candles; or, compared with gas, the cost was as 52s. to 1s. 8d.

The importance of the metal soon led to its manufacture on a commercial scale, and the first result was the production of magnesium wire at half the original price, viz., 10s. 6d. per ounce, thus reducing it at once to the value of sperm candles.

Another step in advance has yet to be made, but whether it will be made at once or by degrees remains to be proved.

The magnesium light is still sixteen times dearer than *gas* light. It must, therefore, be produced at the rate of 10s. 6d. per lb. instead of 10s. 6d. per ounce before it will be able to compete with it; but that this will speedily be accomplished I do not doubt, seeing that sodium, the essential element in its production, is now obtained at a most insignificant price.

It is not, however, to the simple combustion of small magnesium wires, even though multiplied in numbers, that we must look as the only mode of producing light from magnesium. It occurred to me that since magnesium possesses many of the properties of zinc, as regards its combustibility, it would, like zinc, produce brilliant combustion when mixed with oxygenated salts, and that its effects would be even more energetic in proportion to its superior combustibility. In this I was not mistaken, for I found it not only combustible but explosive.

The following are some of the results of my experiments:

1st. A mixture of equal parts of magnesium filings and nitrate of potash, inflamed with an instantaneous bright flash, so vivid as to paralyze the retina for some moments, causing broad daylight to appear darkness. Twenty grains having been ignited in a room, the operator could not distinguish the window for some moments, and it was nearly a minute before he could distinctly discern objects on the table. The flash was very large, and ignited portions of the metal were thrown out to a distance of two feet all round.

2nd. The proportion of nitrate of potash being diminished, the combustion was slower, but still very intense.

3rd. Six grains of the first mixture filled the chamber of a pistol which would hold ten grains of gunpowder. The discharge was loud, a brilliant white flash shot out to a distance of two feet from the pistol, but there was a perceptible interval between the snap of the percussion cap and the explosion

of the powder. The bullet did not quite pass through a $\frac{5}{8}$ board.

4th. Some of the same mixture rammed into a paper case burned very fiercely and with great brilliancy, forming an admirable signal light.

5th. Equal parts of magnesium filings and chlorate of potash, when ignited, flashed off as in No. 1, but with very much greater brilliancy.

6th. A diminution of the quantity of chlorate of potash lessened the rapidity of the effect, but it was always more intense than with saltpetre.

7th. A charge of six grains of mixture No. 5 produced a much sharper report, a brighter flash, exploded more instantaneously, and sent the bullet through the $\frac{5}{8}$ board.

8th. A charge of six grains of gunpowder was about equivalent in effect; perhaps it had very slightly the advantage, judging by the report. It must be recollected, however, that gunpowder is a material manufactured with the greatest care, whereas the magnesium mixture consisted merely of filings and powdered chlorate of potash mixed on paper with the point of a knife.

9th. Less than two grains of the chlorate mixture placed on an anvil exploded with the blow of a heavy hammer, producing a loud noise and bright flash.

10th. In all the experiments the product was an exceedingly light attenuated white smoke, and the barrel of the pistol was in each experiment perfectly lined with a white powder, as if it had been whitewashed.

11th. Each discharge with the chlorate mixture made the barrel of the pistol very hot.

12th. The chlorate mixture rammed in a case burnt like the saltpetre mixture, but with far greater intensity and brilliancy.

These experiments, though rude in their character, and hastily performed without any pretensions to accuracy, serve to show that magnesium constitutes a curious addition to the combustible metals, and that it possesses very striking peculiarities, which, when it can be manufactured at a reasonable rate, will adapt it for very many practical and useful purposes.

AN ACCOUNT OF SOME EXPERIMENTS MADE WITH THE ELECTRIC LIGHT,

TO TEST ITS VALUE FOR NOCTURNAL MILITARY OPERATIONS.

BY J. N. HEARDER, ELECTRICIAN, PLYMOUTH.

THE space-penetrating power of the ray of Electric Light, when concentrated by a good parabolic mirror, has, in my occasional experiments with a powerful voltaic battery, been developed to such an extraordinary extent, as to induce me to institute some experiments, to determine with accuracy its illuminating effect at great distances.

In the year 1849 I made some experiments with the Electric Light on the top of the Devonport Column, some of the details of which are given in "Orr's Circle of the Sciences." Article—"Artificial Illumination." On that occasion the effect of the light at Trematon Castle, 18,266 feet N.N.W., or about 3½ miles from the Devonport Column, was so intense that small handwriting could be read distinctly, the time could be seen by the seconds' hand on a small Geneva watch, and observers standing 90 feet from the Castle gate could count the ivy leaves upon it.

At a mile beyond Trematon, ordinary print could be read.

At Bovisand Battery, a distance of 3⅛ miles, or 16,470 feet, Captain Walker, R.N., found the light to cast a shadow equal to that of a mould candle (six to the lb.) at 30 feet from the same surface, and to be equal to full moonlight.

Having had occasion, in the early part of 1863, to prepare a very powerful battery, I availed myself of the opportunity again to try its effects, and having made known my intention to Lieut.-Colonel Owen, C.B., &c., the Commanding Royal Engineer of the Plymouth District, that gentleman most kindly and promptly arranged for me to exhibit it on the ramparts of the Citadel, and deputed several officers of the Royal Engineers to occupy different distant stations, and report to him the results of their observations.

The principal end that I had in view was to ascertain if

any distant object, say a fort, which should be so far from the light as to be beyond cannon range, could be so illuminated at night as to render it a mark for a third party situated at a moderate distance, say a quarter to half a mile from the object so illuminated. The experiment being a novel one, it was almost impossible to anticipate all the phenomena that might be developed, and provide for all the difficulties that might present themselves in a first trial. There were no means of signalling from the various outposts whether or not the ray was properly directed, and although an officer was stationed in the Citadel in what was deemed an advantageous position for marking the elevation of the ray, and who by means of a bugler was to have given the necessary signals to direct its motions, yet it was found at the onset that the particles of moisture in the atmosphere, through which the light passed, were so brilliantly illuminated that they themselves constituted a bright atmosphere, through which it was impossible to see into the darker space beyond. In consequence of this, although accurate bearings had been taken for the distant objects during the day, by which it was easy to adjust the direction of the ray laterally, its degree of elevation or depression had to be guessed, and it was found next day that in many of the experiments the ray had been thrown too high, and had either passed over the object or had only partially illuminated it. The experiments were, however, on the whole of a very satisfactory character, and demonstrated not only the immense distance to which the light can be thrown, but its perfect adaptability for nocturnal military operations with suitable appliances and under proper management.

The battery which was employed on this occasion consisted of 80 cells, of an arrangement of my own, modified from Callan's cast iron battery, and disposed in a double set of 40. Each cell was of cast iron, in the form of a flat box, containing a flat porous diaphragm, in which was placed the plate of zinc. The cast iron cell was excited by pouring into it a mixture of nitric and sulphuric acid, and the diaphragm was filled with saturated solution of muriate of ammonia. I adopt this fluid for exciting the zinc as it supersedes the necessity for amalgamation, which is very apt to break down with nitric acid arrangements.

The Electric Light was produced between the terminals of coke cylinders, fixed in the axis of a parabolic mirror twenty inches in diameter, of the same kind as those formerly used in Lighthouses. The focal point was adjusted by a slide, so

that the ray could be concentrated or made to diverge at pleasure. The mirror was fixed in a frame which could be set at any required angle, either vertically or laterally.

The following are amongst the phenomena most worthy of interest:—

1st. The focus of the mirror being about 3¼ inches from the back, and the mirror itself being about eight inches deep, all the rays which did not impinge upon the mirror were dispersed radially upon the bystanders and surrounding objects, illuminating the whole most intensely, and producing a very extraordinary effect when viewed from a distance. Many soldiers and officers with their blue and red coats were standing upon the ramparts in the illuminated area, and these, to spectators standing on the Hoe, some 400 or 500 yards off, looked exactly like figures made of brilliant transparent coloured glass. Some boys on the glacis, about 100 yards from the light, amused themselves by throwing up hats and caps, tufts of grass, stones, &c., into the condensed ray as it passed over their heads, all of which appeared like so many intensely ignited balls of fire as they crossed it, and were mistaken by persons at nearly a mile off for brilliant scintillations of ignited matter ejected from the source of light itself. Several attempts were made by observers close behind the mirror to look along the ray, so as to ascertain at what distance objects were rendered visible, but a curious optical effect was observed.

The moisture in the atmosphere (it being rather foggy at the time) was so intensely illuminated that the eye contemplated an expanse of light which seemed only of a limited extent, the bright ray appearing to terminate abruptly at a comparatively short distance. On walking away, however, from the immediate vicinity of the light, the ray seemed to extend further and further, and objects at greater distances were seen more clearly. This effect increased in proportion to the angular distance from the light, to such an extent that observers at two miles distance, looking transversely at it, saw it shooting away into space for miles like the tail of a huge comet, and could easily watch the variation of its direction as it was thrown consecutively on different localities.

2nd. At the Eddystone Lighthouse, a distance of 16 miles from Plymouth, Mr. G. Knott, the light-keeper, formerly in charge of the Electric Light at the South Foreland, reported that the light was very brilliant, equal to a star of the first magnitude. Could see the ray wherever it was directed. Apparently about four miles long. Described it as first

thrown on Eddystone; then Penlee, Breakwater, Bovisand Heights, and then over Plymouth.

3rd. At Penlee Point, about five miles from the light, observers were dazzled on looking at it; but as soon as the first impression on the retina had passed off, they could read the principal lines in the title page of a book, could see the time by a watch, and distinguish each other's countenances. A much greater effect would have been produced had the ray been thrown full on the spot, but it was unfortunately elevated so high that the observers were but just within the edge of the illuminated area.

4th. The ray was next directed on H.M.S. Orlando, lying within the Breakwater, and Captain Randolph reported that the ship was brilliantly illuminated; but as those on board were not aware that the experiment was to be performed, they were too much surprised to make any accurate observations as to its precise intensity. When turned from the ship to the Breakwater, Captain Randolph states that he could have distinctly seen any moving object in the iron cage on the east end of it, a distance of more than half a mile from the ship, the cage itself being 2¼ miles from the light, and that when the light was directed upon the shore at Bovisand, it illuminated about 400 yards in length of the hill and cliffs, thus rendering it open to the fire from a ship's gun. The ray was described as like the tail of a comet, but straight.

Whilst the light was directed on the Orlando, observers at Mount Batten Castle and on the Hoe, and Major Shaw Stewart, R.E., standing at the S.E. portion of the Citadel, saw the ship distinctly, and could even distinguish the ropes, the distance being on the average two miles.

Those at Mount Batten Castle also saw Bovisand Pier so plainly, that they could almost count the poles of the scaffolding then upon it.

5th. The Rifle Butt on Staddon Heights was illuminated twice, viz., in the early part of the evening and at the conclusion of the experiments. Lieut. Bond, R.E., viewing it from Fort Staddon, reported that when first illuminated it was rendered less distinct than before the light was thrown upon it, an anomaly of which the following is an explanation:—

The experiments were commenced at 8 o'clock, before the sky was perfectly dark; the rifle butt, therefore, appeared to Lieut. Bond as a dark object standing up against a sky still retaining the remains of twilight; but as soon as the Electric Light was thrown upon it, it became illuminated to about

that the ray could be cor- ...und, and hence was not so ... pleasure. The mirror ... however, the light was again set at any required ... o'clock, it being then quite dark, it

The following ... considerable brilliancy, although the interest:— ... nearly exhausted; and Lieut. Bond re-

1st. The ... Staddon, an area of about 100 yards right the back, ... was illuminated so as to render distinctly all the ... growth upon the fences, stones, &c. ... of Mannamead, standing near the same ... that he had no difficulty in reading a letter, and ... objects around him were very distinctly illuminated. ... observers at Mount Batten plainly distinguished the bricks ... which the rifle butt is built; and when the light was ... thrown upon Mount Batten Castle and the field in which they were standing, they were able to read very small print in a prayer book, as well as small handwriting. Persons standing on the Hoe, distant one mile, and in South Devon Place, a mile and a half, also saw Mount Batten Castle distinctly illuminated.

6th. As the ray was shifted towards Hooe, Plymstock, and Saltram, the slates on the roofs of the houses at Turnchapel were distinctly seen from South Devon Place and Plymstock, and the hills in the vicinity of Plymstock and Saltram were visible from the north parts of Plymouth.

7th. Mr. Soltau, at Little Efford, two miles from the light, reported that his daughter watched the ray from an elevated field near his house, and saw it, like the tail of a comet, gradually sweeping round over the hills and the woods until it was directed upon the field where she was standing, when it instantly rendered the grass for a considerable distance around her distinctly visible, and she could easily have read ordinary print.

8th. General Campbell, Lipson Terrace, a mile nearer the light in the same line, said that he could have seen to pick up a pin in his drawing room, and that the branches of the trees in front of his house cast a black shadow against it, producing an appearance of creepers growing upon the wall.

9th. The Dome of the Plymouth Workhouse, on Lipson Hill, was twice seen by Lieut. Bond, at Fort Staddon, to be brilliantly illuminated, the distance between the two points being about two miles, and that of the Dome from the light about one mile.

10th. The light having been thrown on St. Andrew's Church, Captain Moggridge, R.E., at Fort Stamford, near Hooe, reported that he could make out all the details of the

masonry, turrets, windows, &c., but not the clock face, distance about two miles. Observers on the Hoe saw the Church brilliantly illuminated, but the glittering of the gold hands and figures of the clock face so confused the eye that the time could not be well made out either from the Hoe or Citadel; but this was from excess, not deficiency, of light.

11th. The windows in several of the houses at Higher Stoke were clearly made out by Miss Soltau, standing in the before-mentioned field at Little Efford, the distance being over a mile and a half. General Nelson, R.E., reported from Penlee Villas a curious phenomenon which he noticed whilst viewing the ray transversely at a mile or so from the mirror. About half a mile only of the middle portion of the ray was visible, having the form of a truncated cone, the first half mile from the mirror and the extreme portions beyond being cut off. I remember to have heard Mr. Vivian, of Torquay, describe a somewhat analogous phenomenon which he had observed on a former occasion when travelling near a ray of electric light.

It would seem to arise either from some variable conditions of the moisture suspended in the atmosphere, or possibly from refraction depending upon the angle at which the ray is viewed.

12th. Eastern King Fort, Longroom. The voltaic battery fast losing power, and almost expended.

Lieut. Gun, R.E., stationed at Drake's Island, stated that he could see the masonry portion of the works of Eastern King Fort, but not the new earthen battery, on account of its dark colour. This Fort could not be seen from the Citadel, on account of the glare of the intervening bright atmosphere.

13th. Drake's Island. This object, like the last, was not visible from the Citadel, and for the same reason; but Lieut. Smith, R.E., stationed at Eastern King, reported that he could have laid a gun on the landing place, but would not have been able to discover men at work in the embrasures. Observers on the Hoe and at West Hoe Terrace could, however, clearly distinguish the masonry repairs which the Forts at Drake's Island were undergoing.

14th. On directing the light towards Mount Edgcumbe, the effect upon the woods was such that the watch on board H.M.S. Cambridge, moored a short distance off, gave the alarm of fire, and all hands were piped before the real cause was discovered.

15th. Lastly, the light was thrown upon the multitude who were collected on the Hoe, and, in spite of the bright

the same degree as the sky around, a ... ousands of easily discernable. When, however ... ne facings on thrown upon it about 10 o'clock, it ... ed amongst the was illuminated with considera ... rs of dress, &c., voltaic battery was nearly ex ... servers situated a ported that at Fort Staddon ... the countenances of and left of him was illu ... ich they were attempt- visible the overgrowth ...

Mr. Clenaghan, of ... periments, although the battery spot, stated that he ... power, yet there was energy enough that the objects a ... ifle Butt at Staddon, as before described.

Observers at ... hemselves, so far as they went, were of a of which the ... character, and there can be no doubt that, thrown up ... experience obtained on the occasion, they might they were ... repeated with far more important results, especially in a p ... arger battery. The conditions sought for were satis- stand ... obtained in the case in which the Breakwater and Pla ... sland were lighted up as marks for the Orlando. ti ... risand and the Rifle Butt as marks for Mount Batten, Drake's Island for Eastern King, and *vice versâ*.

Other observations were arranged, such as bringing the Breakwater Lighthouse open to Picklecombe or Fort Staddon, but owing to the difficulty in determining the degree of ele- vation, these places were missed by the ray passing over them. Many confirmatory observations were forwarded to me from various parts of the neighbourhood, describing the effects witnessed under various circumstances, and all went to prove the intense illuminating power of the concentrated ray, its perfect manageability, and the extraordinary distance at which its effects were appreciable.

One phenomenon which occasions much misunderstanding requires explanation, viz., the appearance of what is termed by every one the ray of light proceeding from the mirror, presenting the character of the tail of a comet, and varying in length according to circumstances. To some, viewing it from certain positions, as for instance near the mirror, the ray appeared very short, and produced a general impression that its illuminating power extended only a certain distance and then ceased, whilst to others more favourably situated it appeared to extend for miles. Now, it may appear strange to observers to deny to them the evidence of their senses, and to tell them that what they saw was not a ray of light at all, yet such is the fact.

Light itself is invisible and ineffective when passing through a transparent medium; it is only the object from

emanates, or from which it is reflected, which is e appearance to which the term ray has been ly from the fact that the particles of moishere, through which the ray of light passes, so as to be rendered visible, and thus dimensions. Now, it is quite evident hich these illuminated particles of ct depend upon the amount of light y which the observer is surrounded. the position in which he is placed, the shorter the distance at which he will be able to distinguish ese illuminated particles in the atmosphere, and *vice versâ.* Hence, although this so-called ray did not appear to observers on the Hoe to reach as far as the Orlando, although the ship was lighted up by it, yet to the observers on board the ship itself a bright ray appeared to be streaming over their heads in a direction sea-ward beyond the Breakwater; it is, therefore, evident that the intensity with which these particles were illuminated, although it was sufficient to render them visible to the ship, was not enough to make them visible to observers on the Hoe, where they were in greater proximity to the source of light, and under the immediate influence of an atmosphere itself brightly lighted up.

One curious effect on the moisture of the atmosphere remains to be noticed; it is the distinctness with which a cloud is illuminated when the light is directed up under it. This experiment I have made on various occasions, and the effect varies according to the character and density of the cloud.

The practical deduction arising out of the results of the observations is, that the most advantageous position for the Electric Light, in order to render it available for the purposes contemplated, is just what was predicated, viz., that the light itself should be placed at the apex or angle joining the two long sides of an isoceles triangle, and the illuminated object and the observers respectively at the other two.

ON CETACEAN REMAINS WASHED ASHORE AT BABBICOMBE, SOUTH DEVON.

BY W. PENGELLY, F.R.S., F.G.S., ETC.

A FEW years ago, but the exact date has escaped me, there was brought to my house a large bone which had been washed ashore on Babbicombe beach, near Torquay. It was not difficult to see that it was part of the vertebral column of a cetacean, and that it had undergone considerable abrasion. That, however, which chiefly arrested my attention was the fact that such parts of its surface as were unrubbed were covered with a darkish stain, from which the abraded parts were free: a fact which led me to conclude that the stain was superinduced. Though less pronounced, it reminded me so much of the dark surface hue of the bones from the Submerged Forest of Torbay, that I thought it not improbable the stain had been acquired by the vertebra having been for a long time in contact with the submarine peaty mass. Having secured the specimen, I put it aside, and thought nothing more of it until last August (1864), when I sent a photograph of it to Mr. Flower, F.R.S., of the Museum of the College of Surgeons, London. In October Mr. Flower, who, in the interval, had had an opportunity of examining several large collections of cetacean skeletons in the Museums of Holland and Belgium, whither he had taken the photograph I had sent him, wrote me that he was "of opinion that it was a cervical vertebra of a whale, of the genus *Balanoptera*." In November I took him the bone itself, when he kindly went with me to examine the cetacean remains in the museum under his care, but we found nothing corresponding to it. It was obvious that it belonged to a whale unrepresented in the fine osteological collection in Lincoln's Inn Fields. On Mr. Flower's suggestion, I submitted the bone to Dr. Gray, of the British Museum. After turning out, with the aid of Mr. Gerard, the numerous cetacean vertebræ stowed away in dark underground cellars, the conclusion was forced on us that the great national collection contains no evidence of the existence of such a whale

as that represented by my specimen; none having a cervical vertebra so thick, so quadrilateral, or having so large a neural canal. From these characteristics, Dr. Gray was of opinion that it was the fourth or fifth cervical vertebra of the *Balanoptera robusta*, a whale unknown to the British fauna, but which had been described by Lilljeborg from an imperfect skeleton found imbedded in the sand on the coast of Sweden. In order, however, to make sure, he sent a drawing of the bone to Lilljeborg, who in a very short time confirmed his conjecture, and sent him a drawing of the same bone from the Swedish specimen.

On January 10th of the present year (1865), Dr. Gray read a paper before the Zoological Society of London, on the Babbicombe specimen, when he established the new genus *Eschrichtius* for the whale it represents, to which he gave the name *Eschrichtius robustus*, which must, therefore, be regarded as a synonym of *Balanoptera robusta* (Lilljeborg).*

Early last month (May, 1865) a portion of another cervical vertebra was picked up on Petitor beach, about half a mile north of Babbicombe. This, too, was sent to my house, and, of course, was at once secured. It has undergone much rougher usage, and is less perfect than its forerunner, of which, though perhaps somewhat smaller, it appears to be the homologue; there can be no doubt that it is, at least, a cervical vertebra of the same species of whale. If homologous, it is evidence, of course, that two individuals of this species have visited the coasts of Devonshire.

These two bones and those cast ashore on the coast of Sweden appear to be the only remains of *Eschrichtius robustus* which have been met with;—remains of two, or at most three, individuals.

It has been observed by Dr. Gray that they belong to a living species; this opinion is based, of course, on the Swedish remains, and is by no means incompatible with the idea that the Devonshire specimens may have been washed out of a deposit in immediate contact with the submerged forest, which there is reason to believe occupies the whole of, and perhaps extends beyond, the area of Torbay; for it must be unnecessary to remark that bones of many species of mammals now living in this country are found in our caverns and bogs mixed up with the remains of extinct forms. The Devonshire caverns, for example, have yielded thirty-three mamma-

* Since this paper was written, Dr. Gray's paper has been printed in the "Annals and Magazine of Natural History," vol. xv. page 492, &c. 1865.

lian species, of which seventeen are extinct and sixteen still in existence.*

From a paper entitled "A description of Happy Union Stream Works at Pentuan,"† read, in October, 1829, before the Royal Geological Society of Cornwall, and in which the author, Mr. J. W. Colenso, minutely described a section at the mouth of the Pentuan valley, St. Austell Bay, Cornwall, it appears that a bed of sand, twenty feet thick, from twenty to forty feet below the surface of the ground, and from about fifteen to thirty feet below the level of the sea at spring-tide high-water, was found to contain trees, chiefly oaks, lying in all directions, remains of animals such as red deer, and remains of whales throughout the bed; that upwards of fourteen feet lower still there occurred a bed, made up of rounded pieces of granite and other rocks of somewhat distant derivation, together with sub-angular fragments of slate and greenstone of the immediate district, in which there were roots of trees obviously *in situ;* and that the intermediate fourteen feet were occupied with beds of various kinds, which may have been of estuarine origin.

In consequence of inequalities in the surface of the rocks on which it reposed, the bed containing the roots of trees varied from three to ten feet in depth, and its upper surface was about forty-three feet below the level of mean tide. It is regarded by geologists as the equivalent of the Torbay submerged forest, which is known to exist in five fathoms water, and there is no evidence that it does not extend to a depth equal to that of the Pentuan bed.

Mr. Colenso gives the following inventory of his whale remains:—"A radius of a whale (imperfect), two phalanges of a whale, and two long bones supposed of a whale." They are all, as well as some others from the same bed, lodged in the Museum of the Royal Geological Society at Penzance, but unfortunately there does not appear to have been any attempt to determine the species or even the genus to which they belong. Though the collection contains one good vertebra, there seems to be nothing homologous to the remains found at Babbicombe, so that I am unable to say whether they belong to the same species.

I have already remarked that the dark hue of the unrubbed surface of the Babbicombe vertebra was perhaps produced by the Torbay submerged forest; but as beds containing marine remains too heavy to be transported with blown

* See "Geologist," vol. ii. page 437, &c. 1859.

† Trans. Royal Geol. Soc. of Cornwall, vol. iv. page 29, &c.

sand, were formed necessarily on a marine or tidal area, and as the Torbay forest undoubtedly grew on the area it now occupies, the bone, if washed out of a deposit at all, could not have been derived from the forest bed, but must have been yielded by a marine stratum immediately above or below it. Moreover the dark stain on the vertebra is, as has been already remarked, less decided than on such bones as have been imbedded in the peaty accumulation.

The Pentuan section suggests that the whale bed must have been above the forest; and to this there appears to be no further objection than that, if even no more than one skeleton had been inhumed, the bed must have contained a considerable number of bones, which it might have been expected would have been washed ashore or dredged up from time to time, especially as it is well-known that, again and again for upwards of three hundred years, bones of various animals have been derived thus from the Submarine forest bed.

Were we to suppose that the hypothetical bed underlies the peat, we must suppose also that it is of much higher antiquity than the whale bed of Pentuan, and thereby increase any difficulty which may exist in the supposition that the remains of an existing species of whale have been intombed in, and washed out of, a bed of marine detritus.

Though admitting that the evidence is very scanty, I have thought it not undesirable, whilst placing on record this addition to the cetacean fauna of Devonshire, to record also the reasons which lead me to think it not improbable that the remains before us were derived from a stratum overlying the Submerged forest of the south-east of our county.

ON THE

CORRELATION OF THE LIGNITE FORMATION OF BOVEY TRACEY, DEVONSHIRE, WITH THE HEMPSTEAD BEDS OF THE ISLE OF WIGHT.

BY W. PENGELLY, F.R.S, F.G.S., ETC.

In a paper on the Lignites and Clays of Bovey Tracey, read before this Association at the meeting held at Exeter in 1862,* I stated that fifty species of fossil plants had been found, in 1860, in the Bovey formation; that of these, twenty-six were new to science, nineteen were well-known Miocene forms of continental Europe, and five of doubtful determination, but probably also of Miocene age; and that on this evidence the formation was concluded to belong to the Miocene period of the earth's history. Following the example of Professor Heer and other continental geologists, I divided this period into five successive stages or horizons, and stated on the authority of the eminent palæophytologist just named that of the nineteen known continental species, fourteen occur in the Tongrian or lowest stage, seventeen in the Aquitanian, twelve in the Mayencian, five in the Helvetian, and eight in the Œningian or highest; that of the two species not found in the Aquitanian stage, one is apparently confined to the Tongrian below, whilst the other has been met with both in this and in the Mayencian above, and may therefore be looked for sooner or later in the intermediate Aquitanian also; that those common to this and to other stages are found in almost all cases in the greatest number of localities in the former; and that in accordance with this evidence the Bovey beds were considered to be of Lower, not Lowest, Miocene age—the equivalents of the Aquitanian beds. I then added that of the twenty-six new species found at Bovey, two had been found subsequently in continental beds on the Aquitanian

* Trans. Devon Association for 1862, page 29, &c.

horizon, whilst the remainder were closely allied to well-known forms in the same stage; and that, so far as they could be determined, the five doubtful species belong also to this level.

The late Professor E. Forbes, in a paper "On the Fluvio-Marine Tertiaries of the Isle of Wight," read before the Geological Society of London, on May 4th, 1853, first called the attention of geologists to the Hempstead beds in the Isle of Wight. He showed them to be a distinct series, and placed them on the Tongrian horizon. Going into details, he divided them into Lower, Middle, and Upper series, which he correlated with the Belgian deposits, as shown below:—

HEMPSTEAD.		BELGIUM.
Upper	=	Rupelian, or Upper Limburg.
Middle	=	Middle Limburg, or Upper Tongrian.
Lower	=	Lower Limburg, or Lower Tongrian.*

This classification was repeated in that distinguished author's posthumous memoir on the subject, which was edited by Mr. Godwin-Austen, and published amongst the Memoirs of the Geological Survey of Great Britain in 1856.

Accepting this arrangement, it follows that the Lower and Middle divisions of the Hempstead series are on, and the Upper division is above, the Tongrian horizon; in other words, as the Hempstead beds are without a break, they are mainly of Tongrian, but partly of Aquitanian age.

Though, prior to 1862, it was not known that the Bovey and Hempstead formations had a single fossil in common, it was not difficult to perceive that they must be of very nearly the same age, since things which are contemporaries of the same thing are contemporaries of one another. Moreover, as from its geographical position there seemed every reason to suppose that plants growing at once in Devonshire and in Belgium must have found a home in the Isle of Wight, I came to the conclusion that a diligent search in the Hempstead beds would be rewarded, in all probability, with the discovery of Bovey Tracey fossils.

Acting on this idea I requested Mr. Keeping, who made the excavations at Bovey, and who resided in the Isle of Wight, to undertake for me the work necessary to the determination of this point. He lost no time in attending to the commission, and in a very few weeks I had the gratification of receiving from him a series of fossils—the results of his labours.

* Quart. Journ. Geol. Soc. vol. ix. Table, page 270. 1853.

Amongst them were ten species of plants, the distribution of which is seen in the following table:—

SPECIES.	Hempstead.	Bovey.	Tongrian.	Aquitanian.	Mayencian.	Helvetian.	Œningian.
1 Sequoia Couttsiæ	×	×	×	×	...	...	...
2 Cyperites Forbesi	×	...	...	...	...	...	...
3 Sabal major	×	...	×	×	×	...	...
4 Andromeda reticulata	×	×	×	...	...	...	...
5 Nymphæa doris	×	×	×	...	...	...	...
6 Nelumbium Buchii	×	...	×	×	...	...	...
7 Carpolithes Websteri	×	×	×	×	×	...	...
8 C. globulus	×	...	...	...	...	...	...
9 Chara Escheri	×	...	...	×	×	...	×
10 C. tuberculata	×	...	...	...	...	...	...

The search which resulted in the exhumation of these fossils was not prolonged beyond a couple of weeks; there can be little or no doubt that had it been continued for six months, as was the case at Bovey, the list of species in common would have been greatly increased.

Of the ten species, all except the seventh and the tenth are new to the Hempstead flora; the second and eighth are new to science. Four of the ten occur at Bovey; six are met with on the continent in the Tongrian, and five in the Aquitanian beds; whilst no more than three reach a higher stage. In short, though it would have been somewhat hazardous to found a chronology on materials so scanty, it is gratifying to find that so far as it goes the evidence is strictly confirmatory of the conclusions previously arrived at from other and entirely independent data. The Hempstead beds are related to both the Tongrian and the Aquitanian series, and more closely to the former than to the latter; and they are on, or very near, the Bovey horizon.

There is a gratification, too, to be derived from the evidence which the foregoing facts afford of the soundness of the principles by which geologists are guided. Relying on these principles, one who had never seen the locality, predicted that certain beds in the Isle of Wight contained fossils of a particular kind, and having a determinate chronological value: a few days' work and the fossils are found, the prediction is verified, and the principles on which it was based are vindicated.

Exception has been taken by some writers to the place in the chronological scheme of the geologist to which the Bovey beds and their contemporaries have been referred. It is said they should be regarded as Upper Eocene, and not Lower Miocene.

The division of the Tertiary or Cænozoic formations into Eocene, Miocene, and Pliocene was first made by Sir Charles Lyell in 1828, and it is well known that originally he so drew the line between the first and second as to class the Hempstead, Tongrian, and Aquitanian series as Upper Eocene; and that he would certainly have sent the Bovey formation to bear them company. Professor E. Forbes too, always regarded his Hempstead beds as belonging to the Eocene—the more ancient of the two periods. A majority of the French geologists, however, from the first dissented from Lyell and Forbes, and placed the line of demarcation lower.

This diversity of opinion is an instructive one, as showing, amongst many other cases, that in proportion as our knowledge of the sequence of events becomes complete, so will the difficulty of dividing the successive deposits into distinct and sharply defined systems or formations be increased, until it will be found necessary, as a matter of convenience, to resort to purely arbitrary lines of separation. Investigation ever and anon brings in a new fragment of the history of the earth's crust—a page or paragraph connecting two previously imperfect portions of the volume—and, by filling in a hiatus, destroys what had long been regarded as two distinct termini: the one an abrupt conclusion of one chapter, the other an unprefaced commencement of another.

But to return. The French and English systematists continued, amidst much confusion, to hold their respective positions until 1857, when Sir C. Lyell, though still believing that very much might be advanced in support of the ground which he had first taken, announced, in the following words, that he had abandoned it:—"I have come to the conclusion that it will be more convenient to draw the line of separation in the place so generally adopted in France, provided that we always regard it as an arbitrary and purely conventional line —one which has no pretensions to be founded on any great change of species, still less on any general revolution in the earth's physical geography assumed to have happened at the era referred to."* To this change, however, some English geologists are not yet reconciled.

The question, it will be seen, is simply one of classification.

* Supplement to Fifth Edition of Manual, page 11. 1857.

It in no way affects the contemporaneity of the formations which have been spoken of, and which are all Lower Miocene, or all Upper Eocene; for they must certainly go together.

By way of illustration. The commencement of the Legislative Union of England and Ireland, and the discovery of the planet Ceres, were undoubtedly contemporary events; they happened on the same day, namely, the eleventh day after the winter solstice of 1800. On this point there is no diversity of opinion, but beyond it there is much. According to the historians of Western Europe the events occurred in the year 1801, and therefore in the nineteenth century; but the historians who follow the chronology of the Greek Church place them in the year 1800, and consequently in the eighteenth century; for the latter draw the line dividing consecutive years eleven days higher up in time than the former do. There is no question of *contemporaneity*, but there is one of *chronology*.

OYSTER BREEDING ON THE FRENCH SYSTEM IN THE WEST OF ENGLAND.

BY H. S. ELLIS, ESQ., F.R.A.S.
Hon. Secretary of the Exeter Naturalists' Club.

MR. ELLIS exhibited a specimen of Dr. Kemmerer's patent Tile-Collectors, which had been used by the Exeter Naturalists' Club in making experiments in oyster culture in the river Exe, to demonstrate the practicability of breeding oysters in the feeding beds or layings on the foreshores of the rivers of the West of England. The Tile-Collector was one of those which had been laid down by the Club during the preceding autumn in the oyster beds of Mr. Challis, at Lympstone, and had been taken up again on the day before the meeting of this Association at Tiverton. On it were several young living oysters, varying in size from three-quarters of an inch to an inch and a quarter in diameter, and which were estimated to be about nine months old, the parent oysters having shed their spawn in the month of September of the preceding year.

The Tile-Collectors* are made of ordinary clay, and are curved hemispherically, but flattened on the top for the convenience of placing others on them. They are sixteen inches long and eight inches wide, and are coated on the inside of the curvature with hydraulic cement, the intention of the inventor being that the cement should be stripped off annually with the young oysters, and be re-coated with cement in readiness for another season. When laid down, the Tile-Collectors require very little attention until the young oysters have grown sufficiently large to be removed and placed separately on the layings.

The great advantage to be derived from making use of Tile-Collectors is, that the oyster merchant (who generally has no right to preserve the oyster fishery in the channel of the river) may retain the spawn of his oysters in his own layings

* The Oyster Breeding Company, of No. 1, Robert-street, Adelphi, London, are the lessees of Dr. Kemmerer's patent.

and under his own control, and may thereby secure for himself a constant supply of young oysters for the more celebrated feeding beds of the eastern coast of England, or a plenty of full grown oysters for the market. The West of England has been famous from time immemorial for its great abundance of oysters, and the climate is most favourable for their breeding; but the present system of dredging young oysters, and the simultaneous abandonment of their feeding beds by provincial oyster merchants, threatens to extirpate oysters altogether, unless the foreshores be replenished and be cultivated in the manner suggested, or dredging be placed under some restriction.

ON ANCIENT PILE DWELLINGS.

THE REV. R. GWATKIN, B.D., in a letter addressed to the Secretaries, and read by them before the Association, suggested that, from a consideration of the passage in Herodotus, lib. v. cap. xvi., in which the Thracian lake dwellings are described in terms very similar to those which are applied to the Swiss lake dwellings, discovered in the last few years, the idea was taken from the river dwellings of *the Beaver*.

W. Brendon, Printer, Plymouth.

REPORT AND TRANSACTIONS

OF THE

DEVONSHIRE ASSOCIATION

FOR

THE ADVANCEMENT OF SCIENCE, LITERATURE, AND ART.

[TAVISTOCK, AUGUST, 1866.]

PART V.

LONDON:
TAYLOR & FRANCIS, RED LION COURT, FLEET STREET.
PLYMOUTH: W. BRENDON, GEORGE STREET.

1866.

CONTENTS.

OFFICERS.

1866-67.

President:

THE RIGHT HONOURABLE EARL RUSSELL, K.G.

Vice-Presidents:

HIS HIGHNESS RAJAH BROOKE. J. CARPENTER-GARNIER, Esq.
CHARLES G. B. DAUBENY, Esq., M.D., LL.D., F.R.S., &c.
ARTHUR RUSSELL, Esq., M.P. J. D. A. SAMUDA, Esq., M.P.
SIR J. TRELAWNY, Bart.

Hon. Treasurer:

E. VIVIAN, Esq., B.A., &c.

Hon. General Secretaries:

Rev. W. HARPLEY, M.A., F.C.P.S. H. S. ELLIS, Esq., F.R.A.S.

Hon. Local Treasurer:

EDWIN STRAKER, Esq.

Hon. Local Secretary:

Rev. D. GRIFFITH.

Auditors of Accounts:

E. APPLETON, Esq., F.I.B.A. G. HEARDER, Esq.

Council:

APPLETON, E. A.
BATE, C. SPENCE
BOWRING, SIR J.
BROOKE, HIS HIGHNESS RAJAH
CARPENTER-GARNIER, J.
CANN, W.
COTTON, R. W.
DAUBENY, C.
ELLIS H. S.
GAMLEN, W. H.
GRIFFITH, D.
HAMILTON, A. H. A.
HARPLEY, W.
HEARDER, J. N.
HUGHES, J. B.
KIRWAN, J.
MACKENZIE, F.
ORMEROD, G. W.
PENGELLY, W.
PARFITT, E.
PYCROFT, G.
RUSSELL, RT. HON. EARL
RUSSELL, A.
SAMUDA, J. D. A.
SCOTT, W. R.
SCOTT, W. B.
TRELAWNY, SIR J.
VICARY, W.
VIVIAN, E.

LIST OF MEMBERS.

Appleton, Edward, F.I.B.A., *Cotswold*, *Torquay*.

Balkwill, Fred., *Plymouth*.
Barham, T. F., M.D., *Highweek*, *Newton Abbot*.
Barnes, Rev. Prebendary, M.A., *The Vicarage*, *St. Mary Church Torquay*.
Bastard, S. S., *Summerland Place*, *Exeter*.
Bate, C. Spence, F.R.S., F.L.S., &c., 1, *Mulgrave Place*, *Plymouth*.
Bayly, John, *Brunswick Terrace*, *Plymouth*.
Bayly, Richard, *Plymouth*.
Berry, Richard, *Chagford*.
Blackmore, Humphrey, *Garston*, *Torquay*.
Booth, W., *Lisworny*, *Torquay*.
Born, Thomas, *Brook Street*, *Tavistock*.
Bowring, Sir John, LL.D., F.R.S., &c., *Claremont House*, *Exeter*.
Brent, R., M.D., *Woodbury*.
Bridgman, C. V., *Tavistock*.
Brooke, His Highness the Rajah, Sir James, K.C.B., *Burraton*, *Tavistock*.
Browne, Joseph, *Devon and Cornwall Bank*, *Tavistock*.

Cann, Wm., *West of England Insurance Office*, *Exeter*.
Carpenter-Garnier, J., *Mount Tavy*, *Tavistock*.
Cawdle, W., *Union Street*, *Torquay*.
Champernowne, A., *Dartington House*, *Totnes*.
Clark, Henry, *Edgcombe*, *Milton Abbot*.
Cole, Robert, F.S.A., 24, *Colville Square*, *Bayswater*, *London*.
Colley, J., *Portland Square*, *Plymouth*.
Collier, W. F., *Wood Town*, *Horrabridge*.
Corrie, A. J., *Glenallon*, *Torquay*.
Coryton, Colonel, *Pentillie Castle*.
Cotton, W., *Pennsylvania*, *Exeter*.
Creed, J., *Whiddon*, *Newton Abbott*.
Cresswell, C. H., *Heavitree*.

Dabb, James, *Plymouth.*
Dansey, George, M.D., *Stoke, Plymouth.*
Daubeny, C. W., M.D., F.R.S., *Oxford Villa, Torquay.*
Daw, C. H., *Parkwood, Tavistock.*
Dennis, J., junr., *Tavistock.*
Derry, W., *Plymouth.*
Divett, John, *President of the Teign Naturalists' Field Club, Bovey Tracey.*
Donne, B. J. M., *Broxmore, Torquay.*
Drewe, E. S., *The Grange, Honiton.*
Durant, — *Sharpham, Totnes.*

Eberlein, Herr, *Tiverton.*
Elliott, W. H., M.D., *Bouverie House, St. Leonard, Exeter.*
Ellis, Henry, S., F.R.A.S., 1, *Fair Park, Exeter.*
Evanson, R. T., M.D., *Homehurst, Torquay.*

Finch, T., F.R.A.S., M.R.C.S., *Westville, St. Mary Church.*
Fox, S. B., *Southernhay, Exeter.*

Gamlen, W. H., *Brampford Speke, Exeter,*
Gibbons, Rev. T., B.A., *St. Peter Tavy, Tavistock.*
Gill, Rev. W., *Venn, Lamerton, Tavistock.*
Gill, J. H., *The Bank, Tavistock.*
Gill, R. B. E., *Endsleigh Terrace, Tavistock.*
Gill, H. S., *Tiverton.*
Griffith, Rev. D., 2, *Taxham Villas, Cheltenham.*
Gwatkin, Rev. R., B.D., F.G.S., *Burntwood Lodge, Torquay.*

Hamilton, A. H. A., *President of the Exeter Naturalists' Club, Millbrooke, near Exeter.*
Hare, W. C., *Tavistock.*
Harland, C. J., F.A.S.L., *Newholm, Torquay.*
Harness, T. B., M.D., *Tavistock.*
Harpley, Rev. W., M.A., F.C.P.S., *Clayhanger Rectory, Tiverton.*
Hearder, G. E., *Torquay.*
Hearder, J. N., *Buckwell Street, Plymouth.*
Hearder, W., *Rocombe, Torquay.*
Hedgeland, Rev. J. W., M.A., *St. Leonard, Exeter.*
Hext, Rev. J., *Kingsteignton.*
Hine, J. E., C.E., 2, *Mulgrave Place, Plymouth.*
Horne, T. B., M.R.C.S., *Adwell, Torquay.*
Hughes, Rev. J. B., *Grammar School, Tiverton.*

Jerrard, J. C., *High Street, Honiton.*
Jones, Winslow, *St. Loyes, Heavitree.*

Kelly, A., *Kelly, Milton Abbot.*

Kendall, W., J.P., *Summerland Place*, *Exeter*.
Kennaway, Sir John, Bart., *Escot*, *Honiton*.
Kirwan, Rev. R., *Gittisham Rectory*, *Honiton*.
Kitson, W. H., 2, *Vaughan Parade*, *Torquay*.

Littleton, T., M.D., *Saltash*.
*Lyte, F. Maxwell.

Mackenzie, F., M.R.C.S., *Tiverton*.
Matthews, J., *Rock View*, *Tavistock*.
Mayjor, J., *Abbey Mead*, *Tavistock*.
Merrifield, S., *Plymouth*.
Miles, W., *Dix's Field*, *Exeter*.
Mills, David, *Lamerton*.
Moore, W. F., *The Friary*, *Plymouth*.
Morris, T., *Abbotsfield Tavistock*.

Nankivell, C. B., M.D., *Layton House*, *Torquay*.
Noel, V. E., M.R.C.S. *Plymouth*.

Ormerod, G. W., M.A., F.G.S., *Chagford*.

Palk, Sir Lawrence, M.P., *Haldon House*, *Torquay*.
Parfitt, Edward, *Devon and Exeter Institution*, *Exeter*.
Pearse, W. C., *Endsleigh Terrace*, *Tavistock*.
Pengelly, W., F.R.S., F.G.S., &c., *Lamorna*, *Torquay*.
Phillips, J., *Devon Square*, *Newton Abbot*.
Pollard, W., M.R.C.S., *Southland House*, *Torquay*.
Prowse, A. P., *Mannamead*, *Plymouth*.
Pycroft, G., F.G.S., M.R.C.S., *Kenton*, *near Exeter*.

Ridgway, C., PH.D., *Marlborough House*, *Exeter*.
Risk, Rev. J. E., M.A., *Crescent Place*, *Plymouth*.
Rooker, A., *Mount View*, *Plymouth*.
Rowe, J. Brooking, F.L.S., *Lockyer Street*, *Plymouth*.
Row, W. N., *Cove*, *Tiverton*
Russell, Right Hon. Earl
Russell, Arthur, M.P., 2, *Audley Square*, *London*.
Russell, Hastings, *Endsleigh*, *Milton Abbot*.

Samuda, J. D. A., M.P.
Scott, W. B., *Chudleigh*.
Scott, W. R., PH.D., *St. Leonard*, *Exeter*.
Shapter, T., M.D., *Barnfield*, *Exeter*.
*Sheppard, A. B., *Torquay*.

* Those members to whose names an asterisk is prefixed are Life Members.

Shute, R., *Baring Crescent, Exeter.*
Spragge, F. H., *Torremont, Torquay.*
Spragge, W. K., *The Quarry, Paignton.*
St. Aubyn, John, M.P., *St. Michael's Mount, Marazion.*
Stewart, C., M.R.C.S., *Princess Square, Plymouth.*

Tancock, Rev. O. J., D.C.L., *The Vicarage, Tavistock.*
Teesdale, C. L., *Swiss Cottage, Exeter.*
Tetley, J. Belmont, M.D., *Torre, Torquay.*
Tinney, W. H., *Snowdenham, Torquay.*
Trelawny, Sir J., Bart., *Trelawne, Liskeard.*
Troyte, C. A. W., *Huntsham Court, Tiverton.*
Tumes, Francis.
Turnbull, A., *Parkwood, Torquay.*
Turner, T., *Manston Terrace, Heavitree.*

Vicary, W., F.G.S., *The Priory, Colleton Crescent, Exeter.*
Vivian, E., M.A., &c., *Woodfield, Torquay.*
Vivian, R. H. D., *Woodfield, Torquay.*
Vosper, J., *Tavistock.*

Weeks, C., *Union Street, Torquay.*
*Weymouth, R. F., M.A., *Portland Villas, Plymouth.*
White, T. J., *Croft Road, Torquay.*
Widger, W., *Union Street, Torquay.*
Windeatt, J., *Tavistock.*
Windeatt, T., *Tavistock.*

BYE-LAWS.

1. The Association shall be styled the Devonshire Association for the Advancement of Science, Literature, and Art.

2. The objects of the Association are—To give a stronger impulse and a more systematic direction, to scientific enquiry in Devonshire; and to promote the intercourse of those who cultivate Science, Literature, or Art, in different parts of the county.

3. The Association shall consist of Members, Honorary Members, and Corresponding Members.

4. Every candidate for membership, on being nominated by a Member to whom he is personally known, shall be admitted by the General Secretary, subject to the confirmation of the General Meeting of the Members.

5. Persons of eminence in Literature, Science, or Art, connected with the West of England, but not resident in Devonshire, may, at a General Meeting of the Members, be elected Honorary Members of the Association; and persons not resident in the county, who feel an interest in the Association, may be elected Corresponding Members.

6. Every *Member* shall pay an Annual Contribution of ten shillings, or a Life Composition of five pounds.

7. *Associates* for the Annual Meeting only shall pay the sum of five shillings; and *Ladies*, the sum of two shillings and sixpence.

8. Every *Member* shall be entitled gratuitously to a Lady's ticket.

9. The Association shall meet annually, at such time and place as shall be decided on at the previous Annual Meeting.

10. A President, two or more Vice-Presidents, a General Treasurer, one or more General Secretaries, and a Council shall be elected at each Annual Meeting.

11. The President shall not be eligible for re-election.

12. Each Annual Meeting shall appoint a local Treasurer and Secretary, who, with power to add to their number any Members of the Association, shall be a local Committee, to assist in making such local arrangements as may be desirable.

13. In the intervals of the Annual Meetings, the affairs of the Association shall be managed by the Council; the General and Local Officers, and Officers elect, being *ex officio* Members.

14. The General Treasurer and Secretaries, and the Council, shall enter on their respective offices at the Meeting at which they are elected; but the President, Vice-Presidents, and Local Officers, not until the Annual Meeting next following.

15. All Members of the Council must be *Members* of the Association.

16. The Council shall have power to fill any official vacancy which may occur in the intervals of the Annual Meetings.

17. The Annual Contributions shall be payable in advance, and shall be due in each year on the day of the Annual Meeting.

18. The Treasurer shall receive all sums of money due to the Association; he shall pay all accounts due by the Association after they shall have been examined and approved; and he shall report to each Meeting of the Council the balance he has in hand, and the names of such Members as shall be in arrear, with the sums due respectively by each.

19. Whenever a Member shall have been three months in arrear in the payment of his Annual Contributions, the Treasurer shall apply to him for the same.

20. Whenever, at an Annual Meeting, a Member shall be two years in arrear in the payment of his Annual Contributions, the Council may, at its discretion, erase his name from the list of Members.

21. The General Secretaries shall, at least one month before each Annual Meeting, inform each *Member*, by circular, of the place and date of the Meeting.

22. *Members* who do not, on or before the day of the Annual Meeting, give notice, in writing or personally, to one of the General Secretaries, of their intention to withdraw from the Association, shall be regarded as Members for the ensuing year.

23. The Association shall, within six months after each Annual Meeting, publish its Transactions, including the Laws, a Financial Statement, a List of the Members, the Report of the Council, the President's Address, and such papers, in abstract or *in extenso*, read at the Annual Meeting, as shall be decided by the Council.

24. Every *Member* shall receive gratuitously a copy of the Transactions.

25. The Accounts of the Association shall be audited annually, by Auditors appointed at each Annual Meeting, but who shall not be *ex officio* Members of the Council.

THE REPORT OF THE COUNCIL,

As presented at the General Meeting, at Tavistock, August 8th, 1866.

THE Council have to report to the Annual Meeting, that the success which has attended the Devonshire Association for the Advancement of Science, Literature, and Art, since its formation, continues uninterrupted.

The fourth annual meeting was held at Tiverton, on Wednesday, June 28th, when the Council and Members were received at the Guildhall by the Worshipful the Mayor, and several of the Members of the Corporate Body, by whom a hearty welcome was given. In the evening the Inaugural Address was delivered by Dr. Daubeny, F.R.S., &c.

On Thursday the 29th, the Association met at 11 o'clock a.m., when the following papers were read and discussed :—

On the Flora of Tiverton	*F. Mackenzie, Esq.*, M.R.C.S.
On the Submerged Forests of Torbay	*W. Pengelly, Esq.*, F.R.S.
On Ancient Pile Dwellings	*Rev. R. Gwatkin*, B.D.
On the Trap Rocks of Devonshire	*W. Vicary, Esq.*, F.G.S.
An Account of some Experiments made with the Electric Light, to test its value for nocturnal Military operations	*J. N. Hearder, Esq.*
On an accumulation of Shells, with human industrial remains found on a hill near the river Teign	*W. Pengelly, Esq.*, F.R.S.
On the Artistic treatment of Devonshire Building Materials	*E. Appleton, Esq.*, F.I.B.A.
On the Crystallization of Felspar in Granite	*E. Parfitt, Esq.*, M.E.S.
On Gold Statistics	*W. Cotton, Esq.*
On Cetacean Remains washed ashore at Babbicombe	*W. Pengelly, Esq.*, F.R.S.
On Oyster Culture	*H. S. Ellis, Esq.*, F.R.A.S.
On Magnesium and its applications	*J. N. Hearder, Esq.*
On the Correlation of the Lignite Formation of Bovey Tracey, Devonshire, with the Hempstead beds of the Isle of Wight	*W. Pengelly, Esq.*, F.R.S.
On Music	*Herr Eberlein.*

In the evening the members dined together at the Angel Hotel, afterwards they attended a Conversazione in the Athe-

næum, at the invitation of the Local Committee, at which were exhibited, among other interesting objects, an extensive collection of English coins, and some brilliant electrical experiments by Mr. Hooker, of Wellington, Somerset.

An excursion to the Black Down Hills had been planned for the 30th, but in consequence of the inclemency of the weather, it was abandoned.

It was determined that the next meeting should be held at Tavistock, and the following officers were appointed for that occasion:—President, The Right Honourable Earl Russell, K.G.; Vice-Presidents, His Highness Rajah Brooke, Sir J. Trelawny, Bart., Arthur Russell, Esq., M.P., J. D. A. Samuda, Esq., M.P., J. Carpenter-Garnier, Esq., Professor Daubeny, F.R.S., &c.; Hon. Treasurer, E. Vivian, Esq., *Torquay;* Hon. Secretaries, Rev. W. Harpley, M.A., F.C.P.S., *Plymouth,* H. S. Ellis, Esq., F.R.A.S., *Exeter;* Hon. Local Secretary, Rev. D. Griffith; Hon. Local Treasurer, Edwin Straker, Esq.

The Council have published the President's address, together with papers and abstracts read before the Association, also a financial statement, and the bye-laws.

Copies of the transactions have been sent to all the members, as well as to the following societies:—

The Royal Society; the Linnæan Society; the Geological Society; the Ethnological Society; the Royal Institution, *Albemarle-street;* the Assistant Secretary of the British Association; the Exeter Institution; the Plymouth Institution; the Torquay Natural History Society; Royal Geographical Society of Cornwall; the Royal Institution, *Truro;* the Literary Society of the Devon and Cornwall Railway Company.

The Council desire to thank the South Devon and the Bristol and Exeter Railway Companies, for the facilities they afforded the members of the Association of travelling to the meeting.

Treasurer's Report of Income and Expenditure during the year ending August 8th, 1866.

RECEIPTS.

	£	s.	d.
Balance in Treasurer's hand, June 28th, 1865	0	13	6
Arrears of Annual Contributions for 1863-4	0	10	0
Ditto ditto for 1864-5	11	0	0
Annual Contributions for 1865-6	43	10	0
Ditto for 1866-7	8	0	0
Life Composition	5	0	0
Associates' Tickets at Tiverton	5	0	0
Ladies' ditto ditto	1	8	0
Sale of Transactions	0	3	6
	£75	5	0

	£	s.	d.
Arrears of Annual Contributions remaining Unpaid for 1862-3	0	10	0
Ditto ditto ditto for 1863-4	1	0	0
Ditto ditto ditto for 1864-5	3	0	0
Ditto ditto ditto for 1865-6	4	0	0
TOTAL	£8	10	0

(Signed) EDWARD VIVIAN, TREASURER.

PAYMENTS.

	£	s.	d.
General Secretaries, for Sundries	2	9	3
Brendon, for Printing Transactions (1865)	21	16	0
,, for Illustrations for ditto	2	6	0
,, for Printing and Posting Circulars	0	5	1
Advertising	0	14	6
Dunn, for Printing	1	10	4
Mills, for Printing Tickets	1	3	6
Postage	1	4	4
Balance in Treasurer's hand	43	16	0
	£75	5	0

We have compared the Books and Accounts presented to us, and find them correct,

EDWARD APPLETON,
WM. PENGELLY, } AUDITORS.

August 7th, 1866.

THE PRESIDENT'S ADDRESS.

EARL RUSSELL, on rising, said: Ladies and Gentlemen,—In presenting myself before you to deliver an address, I must ask for your indulgence. Immersed as I have been in political waters, I have had no time for science, no leisure for literature, and no such opportunity for the enjoyment of works of art as might have qualified me for the task I have before me. In speaking of science, I shall avail myself of the assistance which a friend of mine of high scientific reputation has kindly afforded me. Upon literature I have some remarks to make, founded on superficial reading and observation. The subject of art I shall not venture to touch. The county which produced Sir Joshua Reynolds, and which has had lately to lament the death of Eastlake, is a native soil for art, and needs not my feeble commentary. I shall, however, traversing part of the ground which Buckle and Leckie have so ably surveyed, make some observations on the present aspect and future prospects of the political governments and religious communities now existing in Europe. Those observations, if they produce no other effect, may at least induce others of clearer insight and more practised sagacity to tread the same fields, and where I have wandered unprofitably, enable them to mark the true bearing and position of objects at which many aim, but which few are able to attain.

The progressive improvements and refinements in the analysis of light since the time of Newton have recently led to an unexpected insight into the material constitution of the sun, and the other great light-giving bodies of the universe. High microscopic power, subtle mechanical adjustments of the prism, and an apparatus for polarisation of luminous rays, have, in combination, led to the detection of the character of substances which in a state of incandescence emit these rays. Thus knowledge has been gained of the

metallic constitution of the sun, and of some of the brightest of the fixed stars. Our own time has seen some of the most interesting applications of chemistry, combined with advanced knowledge of the nature and power of light, which it is possible to conceive—I allude to the solar pictures called photographs. Every year sees some new and important improvement in this great discovery. Pictures, in which the most delicate details are faithfully preserved, are printed from the electrotype plate obtained from the photograph. The details of the illuminated surface of the moon are obtained with wonderful accuracy; and a photograph of Jupiter has been taken, in which the belts of cloud are well marked, and the satellites are distinctly shown. The photographic eye is, indeed, more sensitive than the living one: it can receive and register impressions too fine for human vision until increased light and new agency have improved our perceptions. Photography is now an indispensable servant in important meteorological records. It is also important to our social relations, by giving new facilities to the officers of justice for the detection of criminals. Again, the engineer at home can ascertain, by photographs transmitted by successive mails, the progress, brick by brick, plank by plank, nail by nail, of the most complex works on the Indian railways. The physician can register every change of physiognomy in mental malady. The emigrant may carry with him miniatures, such as neither Denner nor Gerard Dow could have equalled in their details, of the persons and scenes with which his dearest memories are entwined.

The most valued, perhaps, of the generalisations of science in the present century are those of the conception of force, as being centered in points of space, not in points of matter; of the principle of the conservation of force; of heat, light, electricity, magnetism, galvanism, chemistry, neuricity, as being modes of force, and finally of their universal convertibility into one another. Remote as such profound conceptions and subtle trains of thought seem to be from the needs of daily life, the most wonderful and astounding practical augmentation of man's power has sprung therefrom. The material advantages to be derived from Oersted's experiments with his small magnets, voltaic pile, and bits of copper wire, seemed hardly appreciable; yet from these, and the discoveries springing from these phenomena, has come the electric telegraph. The philosopher indeed foresaw such an application of his newly-discovered power of converting electricity into magnetism. The inventive faculty of Wheat-

stone gave us the application. On the 6th of August, 1858, the laying down of upwards of 2000 nautical miles of telegraph wire, connecting Ireland with Newfoundland, was effected; and on that day was sent in thirty-five minutes the following message:—"Glory to God in the highest, and on earth peace, good will toward men." The President of the British Association at that time most justly observed—"Never, since the foundations of the waters were laid, could it be more truly said, 'The depths of the sea praise Him.'" That success was not lasting; but again, in 1866, the month of August has witnessed the transmission of messages between the Queen of the United Kingdom and the President of the United States, which augur, I would fain believe, peace and friendship between two mighty nations. When we consider the immense extent, value, and importance of the work that has been accomplished, we shall see reason to applaud the foresight of Lord Bacon, who advises the way of discovery by experiment in this pertinent and encouraging sentence: "For there is no comparison," he says, "between that which we may lose by not trying, and by not succeeding; since by not trying we throw away the chance of an immense good; by not succeeding we incur the loss of a little human labour." The question apt to be put on the announcement of any discovery of abstract science—the question of "*Cui bono?*" has been often answered by fact and by experience. It would indeed be quite enough to say, that science has a value and a dignity of its own; and that those who have employed the faculties with which they have been endowed by the Almighty in the discovery of the laws which He has imposed upon nature, have by their researches ennobled the human race. Yet I cannot refrain from repeating in this place what has often been stated before as to the connection of discoveries apparently the most remote from human uses, with applications the most practical to the production of manufactured goods, to the improvement of navigation, to the mitigation of pain, and a thousand other purposes of daily enjoyment, comfort, and relief. Black knew not that his experiments of the abstract nature of caloric, and his discovery of "latent heat," would point out to Watt the improvement of a steam-engine. Nor did Hunter's medical contemporaries surmise that his experiments on the growth of a deer's antlers would teach him a property of the arteries, suggesting and emboldening him to try an experimental operation, whereby he saved both life and limb, and introduced a new power in surgery, which has rescued thousands of his fellow-creatures from a lingering

and painful death. Thus science, on a wing that never tires, has pursued her flight, losing nothing that she has acquired, but always adding new realms of knowledge to her former conquests.

We have in this country a Museum, whose vast collections would enable us to promote further discoveries in zoology and comparative anatomy, to enlarge the boundaries of our knowledge of nature, to facilitate the researches of the physician, and to open to the geologist new paths by which to ascertain the antiquity of human remains and the first traces of organized matter in the world as it is now known to us. But these vast collections are so "cribbed, cabined, and confined," that their examination is impossible, and their possession useless, while science pauses in despair before the giant of false economy, where he stands with uplifted club ready to strike back the rash intruder who would penetrate into the mysteries he conceals. Let us hope that another year will not pass away without witnessing an ample grant for enlarging the British Museum, and for transferring a portion of its contents to a fitter abode.

The state of literature shews, during the last and the present century, a remarkable change from its early history. The subjects of the higher poetry in ancient times, and for some centuries of modern times, were the careers of great princes and famous warriors, whose contentions decided the fate of states and disposed of queens and heroines of illustrious lineage. Agamemnon and Menelaus, Andromache and Helen, Æneas and Dido, the chiefs among the Crusaders, the knights of Charlemagne, the high-born dames, who attracted not only by their beauty, but by their spells and incantations — such were the persons in whose lot the lovers of poetry of the ancient world and of the middle ages were taught to sympathize, over whose distresses they wept, whose courage and chivalry they admired. But an epic poem in twelve or twenty-four books is too long for our impatience; and poets, although not entirely deserting kings and princes, have found sources of tears, not in Troy, Rome, or Jerusalem, but in British homes, and have kindled admiration without introducing us to heroes who throw the spear and wield the sword. Pope is one of the least pathetic of our modern bards, yet he has found the art of reaching our affections by his touching allusion to a common office of filial love.

> "Oh, friend, may each domestic bliss be thine,
> Be no unpleasing melancholy mine;

Me let the tender office long engage,
To rock the cradle of reposing age;
With lenient arts extend a mother's breath,
Make languor smile, and smooth the bed of death;
Explore the thought, explain the asking eye,
And keep awhile one parent from the sky."

Cowper is among those who have been most successful in exciting our sympathies by the delicacy, simplicity, and depth with which he has painted scenes the most ordinary, and occupations the most commonplace. The tea-table of a quiet family party; the arrival and reading of a newspaper; a morning walk in a country where there is no beauty and no sublimity; an old lady whose failing faculties allow her no further use for her "shining store" of needles—these are themes which might appear too trivial or too common to furnish volumes for the same shelf with Milton and with Virgil. Yet Cowper is not alone in the art of fashioning a poetic language by which domestic scenes are made to excite the deepest emotion. Gray has built in lofty rhymes temples to bards and chiefs; but nowhere does he so touch our feelings as when he records, in his "Elegy in a Country Churchyard," "the short and simple annals of the poor." Goldsmith has painted the virtues which flourished in a quiet village. He and others have raised up images which, warmed with the Promethean heat of poetry, start into life, and fill us with as much sympathy as the picture of Priam bereft of his heroic son, or Dido reproaching her faithless lover. In order to accomplish this task with success, the difficulty of choosing proper terms which shall faithfully paint the object, and yet not be too low or too familiar for poetry, is, perhaps, still greater than that of the poet who sings the deeds of heroes and the distresses of queens; for in this case language lends itself to the purpose of the poet. Cowper has described admirably the pains as well as the pleasures of his employment:

"There is a pleasure in poetic pains
Which only poets know. The shifts and turns,
Th' expedients and inventions multiform,
To which the mind resorts in chase of terms.
Though apt, yet coy, and difficult to win;
T' arrest the fleeting images that fill
The mirror of the mind, and hold them fast,
And force them sit till he has pencilled off
A faithful likeness of the forms he views;
Then, to dispose his copies with such art,
That each may find its most propitious light,
And shine by situation, hardly less

Than by the labour and the skill it cost;
Are occupations of the poet's mind
So pleasing, and they steal away the thought
With such address from themes of sad import,
That, lost in his own musings—happy man!—
He feels the anxieties of life, denied
Their wonted entertainment, all retire:
Such joys has he that sings."

By this immortal art the Scottish cottager, gathering his family around him for the prayer of Saturday night; love blighted by the pride of heraldry; the English peasant enjoying the respect due to a life of honest toil; the miserable fate of the victim of passion and of vice; the pangs of ill-requited labour; such have been the topics of Burns, and of Tennyson, of Crabbe, of Wordsworth, and of Hood. The poet's eye glancing from earth to heaven, from heaven to earth, has borrowed from earth the true colours of human life, and from heaven the ray of eternal love, which smiles on our virtues, and carries consolation to our sorrow and our repentance. Two works may be here mentioned, of which one is not a poem, and the other cannot strictly be said to be conversant with a simple domestic subject. The "*Promessi Sposi*" of Manzoni is an epic in prose; the story of an Italian peasant and his bride, whose many vicissitudes enable the author to display the virtues of humble life, the defects of a worldly priesthood, and the sublime doctrines of the Christian religion. The other work is "Evangeline." The melancholy interest of the subject, the affections displayed by Evangeline and her lover, the gorgeous splendour of nature in a southern climate, the most sad catastrophe, give to this poem a hold over the attention, and a power over the feelings, which few poets have been able to attain. We may now perhaps conclude, that, although we may never again see a Homer, a Virgil, a Dante, or a Shakespeare, the age of poetry is not passed, and that, while

"Theirs was the giant race before the flood,"

the muse may yet inspire in Europe and America, perhaps in Asia and Africa, songs which the world "will not willingly let die."

The muse of history has likewise her worshippers, and can count many in these latter days who have not worshipped in vain. Hallam, Macaulay, and Prescott have passed from among us, but Carlyle, Froude, Motley, and others still happily survive to honour and illustrate the times in which they live. One observation must strike every body who reads

the most popular modern historians. Events three centuries distant are far better seen by us in all their details than they were by their immediate contemporaries. We know with precision what Queen Elizabeth said to the Spanish and French ambassadors concerning her marriage, and the steps by which Mary Queen of Scots compassed the death of her husband. So that, although we cannot penetrate the motives and deep designs of sovereigns, we know what they professed to their most secret counsellors, and the orders which they gave to their most trusty instruments and agents. Thus a light is thrown upon modern history, not discoloured or refracted by those obscure and unsafe traditions which Niebuhr and George Lewis have taught us to distrust in our legends of ancient Rome; and thus history has become far more accurate and authentic than it has ever yet been.

Leaving the past, you will now perhaps allow me to cast a glance forward, and endeavour, through the dim and doubtful mist, to discern 'the shadow of coming events.' What is the tendency of the present political and religious institutions of Europe? Is it true that there are any signs of degeneracy among the civilized nations of the western world? If Corinth, and Carthage, and Rome herself perished, is there not reason to apprehend that the chief nations of Europe may also fall into decay? I can see no reason to apprehend such a revolution, no reason to fear that the New Zealander will ever behold the ruins of St. Paul's. Among the changes which the last three centuries have seen, there are scarcely any, it appears to me, which do not tend to improvement and to stability. The revival of letters at the end of the fifteenth century revealed to Italy, to France, England, and Germany the great poets and historians of Greece and Rome. The spirit of enquiry promoted by Copernicus, by Galileo, and the Reformation, led to an increased intercourse between nations, which ultimately contributed to promote feelings of brotherhood, while it has in no way enervated the men of this generation. Valour in war, and fortitude under hardships, have shone no less brightly in the wars of Europe and America between 1850 and 1866, than in the old days of the Crusades. Nor has the enjoyment of the comforts and luxuries of life tended, in my opinion, to weaken manly virtue, to enfeeble patriotism, or to prevent self-sacrifice. Governments have become exceedingly susceptible to the flow and ebb of public opinion without becoming degenerate or timid. While such is the case, what are the changes which we may apprehend? Not certainly such an irruption of the barbarians as that which

overthrew the Roman Empire. The constant tendency of the relations which have been introduced by conquest, or by commerce, between civilized and savage nations for the last three centuries has been, on the contrary, towards the servitude or extirpation of the savage nations, and the supremacy of the civilized communities. Even the noble savage of North America and New Zealand seems destined to extinction, and other races, imperfectly civilized, although to a certain extent used to our European manners, appear doomed to decay and perish. The best hopes for the permanence of civilized communities in Europe must depend, however, upon the maintenance of their independence, and the progress of their liberty. A single sovereign governing the greater part of Europe, and controlling the rest, would very soon establish a despotism quite incapable of maintaining for any long period the independence of the nations over which he ruled. Arms, arts, religion and morals, science and literature would all decay beneath its blighting influence. The history of the decline and fall of the Roman Empire would be renewed under the pernicious domination of an absolute master. The liberties of Europe, however, do not seem exposed to such danger. Her present state may be rather described as one of trial and transition, tending to something better, but by no means assured in respect to the form which her various states may ultimately adopt. Machiavelli describes the Republic of Florence of modern times as fluctuating, not between servitude and liberty, but between servitude and license. Such, too, was the history of several of the European monarchies. These irregular constitutions of the middle ages were nearly all destroyed in the sixteenth century; that of Spain by Cardinal Ximenes; that of Florence by Charles the Fifth; that of France, after receiving many rude shocks from Charles the Eighth, ceased to exist in the reign of Francis the First. England almost alone preserved her ancient liberties, and, at the Revolution of 1688, established and asserted all the fundamental principles of civil, political, and religious freedom. France, a century later, proclaimed those liberties which have since been known as the principles of 1789. Of some of the states on the Continent it may be said—"*Nec totam libertatem, nec totam servitutem pati possunt.*" They cannot, however, be said to be falling into servitude; they are more truly described as seeking those securities for freedom which many nations have sought in vain. Few, indeed, can yet be said to have settled down on any fixed form of free institutions. Our own constitution, per-

fect as we deem it, is, perhaps, too complicated, and requires too much patience and forbearance, for successful imitation. Italy is endeavouring nobly to place her liberties on a firm basis—Germany is only beginning her revolution; and her communities, replete as they are with men of vast learning and of profound views, are about, like Icarus, to try their wings, in danger at once from the scorching sun of military despotism above them, and the deep sea of metaphysical speculation underneath.

There is one change very remarkable, too clearly borne along by the current of the times to escape our notice. Several states of small extent, and inconsiderable population, have both, in ancient and modern times, been "native to famous wits, or hospitable." The area of Attica was about 700 square miles. The number of citizens in her most flourishing period was about 20,000, and was so estimated by Demosthenes. This number would give about 80,000 for population, and, with the strangers and 400,000 slaves, a population little exceeding half-a-million. The population of Florence at the time of the death of Lorenzo de Medici, in 1492, reckoned by the number of baptisms, would be 66,975. Benedetti Varchi reckons them at 70,000, which is an approximation sufficiently accurate. The number of taxpayers assessed to the *Catasto* appears to have been, in 1470, 40,238. But when we enumerate the great men of Athens—Miltiades, and Pericles, Eschylus, Sophocles, Euripides, Socrates, Plato, and Aristotle (to whom, as a stranger, Athens was hospitable), Thucydides, and Xenophon, Demosthenes, and other orators; and of Florence, as Dante, Cosmo, and Lorenzo de Medici, Galileo, Michael Angelo, Machiavelli, and many others, both Athenian and Florentine, we may well doubt whether a small free state is not the best nurse of great talent in statesmen, authors, and artists. But we must recollect, that when these states flourished, there was scope afforded in them for the warrior and the orator, as well as the poet, the sculptor, and the painter. In our days, on the contrary, the small states of Germany and Italy have languished in a state of decline and insecurity, rather permitted to exist than able to live; and thence the stirring talent of those petty sovereignties has felt the want of a wider stage, instead of a patriotic attachment to its native soil. Such must then be the general result, as it is the general tendency. Yet, wherever a small community is free in its institutions, and happy in its independence, it would be an act of inexcusable ambition to annex it without politi-

cal necessity to a larger state, in order to gratify a warlike sovereign greedy of aggrandisement.

While the political spirit of the age tends towards the absorption of smaller States, and the consolidation of great Empires, the religious tendency of the times has a totally different current. After the conversion of Constantine, the unity of the Christian Church was the object of the secular, as well as of the ecclesiastical mind. Athanasians and Arians banished and despoiled each other. Those who honoured images in the churches, and those who destroyed them, waged against each other the most merciless of wars. In the same manner, and for the same purpose, when the reformation broke out, blood flowed in rivers, both in the field and on the scaffold, in order to maintain or destroy the supremacy of the Church of Rome. Like intolerance was displayed on the side of the Reformers as on that of the Romanists, though, as Schiller has remarked, in his history of the 30 years' war, their intolerance was not equally logical nor equally consistent. But, in fact, both parties thought themselves in possession of the right interpretation of the will of God, both thought themselves entitled to enforce it. This conviction, somewhat mitigated in practice, pervaded the legislation of England and France, till near the end of the last century. In England, by the laws of Charles the Second, penalties and prohibitions were enforced against those who did not take the Sacrament of the Lord's Supper, according to the ordinances of the Church of England; against those who preached within five miles of a market town, or assembled for divine worship in a manner not favoured by law. Soon after the revolution, these enactments were to a certain degree repealed by the Toleration Act; but Roman Catholic priests were not allowed to say mass, and many cruel statutes were aimed at those who professed the ancient faith. Similar severity was introduced in France, and directed against the followers of the reformed religion. Two different and contradictory systems were proposed to Louis the Fourteenth, and both were adopted. The one suggested by the Jesuit confessor of the king, proposed to consider the whole Protestant body as converts to the Catholic Church, and to treat them as such; the other system was to look on the Protestants as obstinate heretics, to pursue them, and charge them by military force whenever they assembled for divine worship, to banish them from the country. In consequence of these violent measures many sufferings were endured, and many French emigrants took refuge in England; but neither

was the reformed religion rooted out in France, nor the Roman Catholic Church extirpated in England or Ireland. At length, about 1778, the rigour of the penal laws was mitigated by the English and Irish parliaments. Other measures, in regard to the Protestant Dissenters, the Roman Catholics, and the Jews, have followed, and the edifice of religious liberty has during the present year been nearly completed. In France the National Assembly, in 1789, put a total stop to religious persecution. Upon complying with certain formalities, Protestants and Jews are as free to celebrate public worship as the Roman Catholics themselves. Spain is the only country in Europe where diversity of religious worship is not tolerated. But Spain must suffer in her political welfare for maintaining the attempt at religious unity. The consequence of this general religious liberty in Europe has been to mitigate animosity, to promote charity between the members of different sects, to strengthen the authority and the freedom of private judgment. In the United States religious freedom is, according to all testimony, universal.

While such has been the progress, and such is the prospect of religious liberty, it would be vain to expect that the unity which has not been effected by persecution should be attained by persuasion. No one can hope to see the Church of Rome, the Church of England, Lutherans, Calvinists, Presbyterians, Baptists, Congregationalists, and Unitarians, concur in one form of religious faith. But although unity of creed and unity of church government are unattainable, unity of spirit may be reached. I will explain my meaning further.

Soon after the promulgation of the Christian religion, men began to argue on questions involving most mysterious doctrines of dogmatic theology. To daring and subtle minds it appeared tame and inglorious to rest contented with the simple precepts for the conduct of life contained in the Gospel. The less obvious the meaning of Scripture, the greater the glory of the human commentator who deduced logical propositions from that which was hard to be understood.

So likewise at the Reformation, Luther and Calvin, Zuinglius and John Knox, built up their systems and organized their ecclesiastical discipline. These speculations, while they have tended to form churches or religious communities firm in their adherence to their own standard, have not produced unity of faith. Nor does such a result appear more probable now than it did three centuries ago. If, however, all these churches and religious communities, keeping their own creeds and systems of faith, would insist upon those lessons of love,

of mercy, and of forgiveness which are contained in the Gospel, a unity of spirit might be obtained; then the Divine words, "If ye love me, keep my commandments," would receive universal application; then, indeed, we might hope to see the vices of our great cities, the ignorance, the superstition of our villages and rural districts, the crimes and omissions of both, rebuked by the spirit of Christianity. At present we hope we are somewhat better than the generation we have succeeded; we might then expect that our sons would be far better than we are. Then, indeed, we should understand the full meaning and intent of that lay of the angels which heralded the birth of Christ—"Glory to God in the highest, and on earth peace, good will toward men."

LANGUAGE,

WITH SPECIAL REFERENCE TO THE DEVONIAN DIALECTS.

BY SIR JOHN BOWRING, LL.D., F.R.S., M.R.A.S., ETC.

A FEW observations on the general subject of language and languages may not be an unbecoming introduction to some remarks on the Devonian dialects. The period is not remote when national and generally recognized and adopted tongues will supersede or absorb all provincial idioms. This result will be aided, and indeed necessitated, by the constantly growing facilities of intercourse, the progress of education, the reading of books and newspapers, and generally by the spread of knowledge, and the development of thought.

In an address necessarily limited, incomplete, and somewhat desultory, I propose to illustrate by some examples conclusions at which I have arrived as to the origin, history, and progress of languages, whether national or provincial.

The subject is most extensive, and would require years of diligent study to complete, and volume upon volume to communicate anything like a comprehensive or exhaustive view of the whole. But the contributions of geology and ethnology to the early history of man can never be equally or contemporaneously followed up in the field of language. Of man's pre-historical condition, individually and socially, some instructive evidences are found. How he lived, and what he fed on, where he dwelt, and how he protected himself from heat, cold, or other enemies, we are now beginning to learn; but as to the sounds he uttered, the languages he spoke, the forms of oral communication with his kind, we know absolutely nothing. It is in a very late period of the generations of man that any written annals record his doings. We are as little acquainted with his early mental aptitudes, as with the habits or instincts of extinct species of animals, and know less of his external appearance than we know of those crustacea, the hardness of whose coverings has protected them from the destructive ravages of time. The origin of

language, then, is hid in the deepest obscurity. The farther we go back into the past, the less is the accessible evidence of the physical and intellectual state of our race, though there are abundant proofs of the very lowly condition of primitive man. There could have been no more a revelation of a perfect language than of a perfect civilization; and it would be as reasonable to expect to find an acquaintance with the laws of gravitation, or solutions of the deepest mathematical problems among savage traditions, as grammatical forms and refinements in the rude utterances of the prehistoric races. Perhaps in the present day nothing exists, bearing the human name, so rude as was the state of man when he lived contemporaneously with the creatures whose species have ceased to form a part of the animate world. Yet there are in some spots of the universe, even at the present hour, human beings who cannot count five upon their fingers, have no designations to distinguish virtue and vice, have no thought for the morrow, and whose language is confined to a vocabulary of at most two hundred words. Treble this number would perhaps even now exhaust the store of a wholly uninstructed English peasant. Seven hundred characters, each representing a word, are taught in the primary schools of China.

The languages of literature—of civilization—undergo changes, not so much by the loss of any existing words, as by a constant influx of those new additions to the nomenclature, which are required to mark and to represent the progress of intelligence. It is believed that more than thirty thousand words have been added to our recognized vocabulary since the appearance of Johnson's Dictionary; and certainly, if English names were given to all the distinct varieties of animal and vegetable life, to say nothing of the non-sentient worlds which year by year, and almost day by day, are introduced into the fields of discovery, neither would thirty thousand, nor three hundred thousand, novel words suffice for our Lexicons.

It may be safely said, that for one ancient word that has been lost, twenty modern words have been found. But this circumstance adds to the interest of the investigations regarding words which have been abandoned in written documents, or in ordinary colloquies, but have retained their hold in provincial and obscure recesses; and to seek them, and to find them, is to render no small service to Anthropology, Ethnology, as well as to the history and science of language. Such words, confined to a narrow locality, bear in themselves the proof of

their antiquity; and as communication and intercourse are facilitated and increased, they will either be amalgamated and absorbed in the general idiom, or be abandoned because misunderstood or unused in other districts. After an absence of half a century from Devon, I was surprised to find the word "slotter" (spilt liquid) scarcely known, and little employed; "burler" and "burling," "fuller," "tucker" and "sheaman," "rack" and "rackfield," "linhay," "duroy," "worley," "lindsey," "serafine," "bayeton," "estamene," and many other familiar names had disappeared with the disappearance of the woollen trade. I seldom hear the word "soce!" (socii) addressed by masters to their workmen, or by workmen to one another: so "suent" and "scovy," admirable designations of what is smooth and regular, and of the contrary, are words but rarely heard. A "wisht" is no longer a dismal, disagreeable man. Even the common names of places have undergone strange changes; *Exon*, not Exeter, *Kirton*, not Crediton, *Barum*, not Barnstaple, in my remembrance usually headed the letters from the several spots; and were a Devonshire man who died two generations ago now resuscitated, he would ask where Devonport is, and what had become of Plymouth Dock? and would be amused when told that a sense of offended dignity had called in the aid of an Act of Parliament, to declare that a town of more than twenty thousand inhabitants was something better than a dock at the mouth of the Plym.

Two processes, then, are constantly going on in the world—the disappearance of ancient idioms, and the fusion of many languages into one. Hundreds of languages, even in the memory of man, have ceased to exist; and the farther we go back the greater is the number we discover. Where wants are few, ideas limited, invention dull, the words of a language are soon told, and often confined to a small number of human beings. Early travellers in Australia found that the idioms of adjacent tribes had some resemblance, but there was little or none in those of the tribes that were remote. In the multitudinous tongues of the natives either of North or South America there is scarcely any affinity; and in the interior of Africa distinct languages almost without number are found; but there the language of the higher civilization, Arabic, is infusing itself with the progress of the Mahomedan faith into Africa, and doing the work which has been done in Europe by the Sanscrit, Greek, and Latin among the languages generally called Semetic.

The disappearance of imperfect languages, and the substitution of others more adapted to the development of mind,

the inventions of Science, and the progress of discovery, are among the obvious marks of progressive civilization; and the languages which are likely to last longest, and to spread most widely, are those that most readily welcome the terms which advancing knowledge needs. In this respect our own is admirable. Derived mainly from two sources, the Gothic and the classic, the first greatly preponderating, it has added to our vocabulary with wonderful rapidity new words taken from every part of the known world, while many new terms and combinations have been made out of the ancient elements. The word *telegram* found instant acceptance, from its obvious appropriateness, and for it *telegraph* had prepared the way. We are more courageous than most of our neighbours. The Germans call cotton "tree-wool;" the Dutch call potatoes "earth-apples;" the French call railways "roads of iron;" yet commerce has given universality to some words, as *coffee*, from the Arabs, *tea* (*te* or *chai*), from the Chinese, *tobacco*, from the American Indians, the *kangaroo*, from the Australians, the *orang-utan*, from the Malays, the *armadillo* from the Spaniards.

It is not a hazardous prophecy to announce, that in the course of a few generations no language but English, and that a grammatical English, will be spoken through the British territories. The old British is dead, the Manx is dying, the Gaelic will perish next, then the Welsh, and last probably the Erse or Irish; and then our mother-tongue, emphatically English, will be the sole sovereign over the whole dominions of our written and spoken literature. Education and fashion will cause the diversities of colloquial idioms to disappear. Half a century ago, the county of a country gentleman was easily discoverable wherever he went. "You are a Devonshire, a Yorkshire, a Kentish man," frequently interlarded a conversation. The confusion between *v*'s and *w*'s signalized the Cockney; an Irishman when he put out his tongue was said to be catching the English accent. And I remember, when Jeffery sat in the House of Commons, and was said by the Edinburghers to have no tinge of the brogue, that his Caledonian origin was detected in almost every sentence he uttered. Sir Robert Peel never abandoned the Lancashire pronunciation, *one* (whon), and *put* (pŭt); and though the House of Commons is said to be the school where correct pronunciation is to be studied, *gold* and *Rome*,*

* Rome was pronounced variously in Shakespeare's time, as shown by play upon the word. "*Rome* shall give him *room* enough." "This *Rome* shall remedy." "*Roam* thither then." "I have *room* with *Rome* to curse." King John III. 1.

schedule and *spirit*, *privacy*, and twenty other words, have two different utterances, each recognized as proper. Not long ago, to quote from multitudinous examples, *oblige*, *tune*, *supreme*, *stirrup*, *squirrel*, had a fashionable pronunciation which has passed away. I would notice here, that our mode of teaching the alphabet, and the varying pronunciation given to the same letters, leads to great confusion among foreigners as to the sounds of words. A word is but the rapid blending or fusion of letters. A stranger would never fancy that *cat* could come from *see a t*, which should make *sat*. The letters should be *ke a te*. The Dutch make their primary schools teach the alphabet by placing the same vowel sound invariably after the consonant: thus—*a*, *be*, *ke*, *de*, *e*, *fe*, *ge* (hard), *he* (aspirate), *ke*, *le*, *me*, *ne*, *o pe*, *keu*, *re*, *se*, *te*, *u*, *ve*, *we*; while we say *be*, and *ef*, *de*, and *el*, putting the vowel sometimes as a prefix, sometimes as a postfix, to the consonant.

If fashion has some influence upon the modes and modifications of utterance, education, in its turn, produces other changes. The power of speech is improved by the desire of speaking well. Not to aspirate the *h*, or to aspirate a vowel unbecomingly; to substitute the *v* for the *w*, or the contrary; to err in the mode of pronouncing any common word, would be sufficient to hand over the mis-speaker to condemnation for vulgarity. So in our county the old simple grammatical forms are superseded; nouns are properly declined, verbs properly conjugated, by all educated people; *sifing* has been replaced by *sighing*; the *davered* is now a *withered* flower, and the *ant* has driven the *emmet* out of the field. I see with some sorrow the gradual disappearance of many of those pretty and poetical words by which the people designate flowers, insects, birds, animals, and other natural objects of fields, woods, hills, and streams. Daisies, blue-bells, honeysuckles, forget-me-nots, cowslips, oxlips, coltsfoot, dandelions, primroses, and such, may live, "married," as they are, "to immortal verse;" but who can answer for the *bloody-warrior*, the *mournful-widow*, the *love-lies-bleeding*, the *London-pride*, the *parson-in-the-pulpit*, the *butter-* and the *gilty-cups*, the *prince's-feather*, the *daffy-down-dillies*, or *Lent-lilies*, the *John-that-goes-to-bed-at-noon*, the *shepherd's-weather-glass*, the *long-purples*, the *kiss-me-at-the-garden-gate*, the *boy's-love*, the *bachelor's-buttons*, the *butter-and-eggs*, the *lords-and-ladies*, the *hay-maidens*, the *blue-cup*, the *beggar-weed*, the *milky-dashel*, the *withy-vine*, the *pixie-puff*, the *old-man's-beard*, the *zauer-zab*, the *traveller's-joy*, the *cuckoo-birds*, the *bird's-eyes*,

the *wind-flowers*, and other such sweet sounding, suggestive names? We may keep *cock-robin-redbreast* and the *jenny-wren;* they are sacred, as "God Almighty's cock and hen;" but the *blue-tail*, the *golden-gladdie*, the *dish-washer*, the *quist*, the *hoop*, the *colley*, the *culver*, the *wet-my-foot*, the *heckemal*, the *Jack-a-long-legs*, the *shear-a-muze*, the *oak-web*, the *lady-bird*, and many more will probably fly away. *Cuckoos*, *frogs*, and *toads*, will lose their *spittle;* the *devil*, his *finger-rings*, *coach-horses*, and *snuff-box;* and the peasant will look into the heavens in vain for the *cock-leart*, and *lamb's-wool sky;* or among the grass for the *clyder*, the *long-cripple*, the *want*, or the *slow-worm*.

As languages must always be, to a great extent, the representatives of civilization, those of very rude nations will consist of very few words, and those words of very few letters. Even in our days there exist languages which have only seven consonants and five vowels; and it is probable the earliest had no more than five consonants, and three vowels: *b* not distinguishable from *v* and *p;* *s* confounded with all other sibilant sounds; *d* and *t* even now are the same in many tongues; *k* like the hard *c;* *g* has two sounds, the hard and the soft; *l* and *n* are not distinct sounds in several uncultivated idioms. *A*, *i*, and *u*, the three separate vowel utterances, are in every language; but our *e* is the rapid utterance of *a* and *i* (*ai*), as in *maid;* and *o* that of *a* and *u* (*au*), as in *austere*.

Alphabets are often very imperfect elements for the construction of words. The very first letter in ours has five distinct, separate sounds—*all*, *and*, *able*, *cat*, *far*. We give to three of the simple letters of the Saxon alphabet complicated consonants to represent them. We have the sounds, but not the letters, of the Scandinavian å, and the Gothic ǎ or ŏ or ŭ. We have only twenty-six letters to represent thirty-four simple, and six complex, sounds.

In our alphabet *x* is superfluous, being a combined *k* and *s;* *ch* ought, as in most alphabets, to have a separate letter; *q* cannot stand alone, and the *qu* should, as in Dutch, be superseded by *kw*, or, as in Spanish, by *cu*.

Probably on no one subject has so much nonsense been written, or so much ignorance displayed, as in the theories of there having been a single primitive language first communicated to Adam by divine revelation, to which language all others are to be traced back. Common opinion supposes this language to have been Hebrew, because that was employed by the Jewish race, though Syro-Chaldaic was spoken

by Jesus and His apostles. One man has written to prove that the language of paradise was that which is still current in some of the islands of the Pacific; another has insisted that Welsh is entitled to the distinction; and a book, published by an author not unknown to fame, was believed to have demonstrated that the Euscara, or Biscayan, was the fascinating speech with which Eve tempted Adam.

Had languages emanated from a common source, no words, habitually and frequently used, denoting objects constantly present, could ever have disappeared; identical words, or something like them, would be everywhere found; but such are found nowhere, unless there has been intercourse, and where there has been *no* intercourse, identical words with an identical meaning are never found. Take the commonest of words—*man*, the human being. Had there been a primitive language from which all others have descended, such a word must have traversed all time in every tongue, as it has in all those of Gothic origin, whether descending through the Saxon or Scandinavian branches. But I could mention no end of languages, in each of which the word for *man* is different from all the rest. The Russians call a man *chelowick;* the Chinese, *jen;* the Japanese, *fitowa;* the Malays, *orang;* the Gallic, *duine;* the Welsh, *gwr;* the Arabs, *edem;* the Greeks, *anthropos;* the Latins, *homo;* the Magyar, *ember;* the Biscayans, *gizon;* the Tagals, *taro,*—not to mention a hundred others having no shadow of resemblance. Yet the word itself, *man*, being a simple sound, is found in multitudinous tongues, but with multitudinous meanings. In Chinese, for example, it means something which is contrasted with man, something inhuman, beast-like. In French it means a hamper; in many idioms a hand. Had those been a primitive and common language to which such a word belonged, it could not have disappeared, as it has not disappeared, from any of the descendants of the Gothic.

The theory that the Sanscrit, Greek, and their descendants are in their several branches to be traced up to a more primitive, pristine, aboriginal tongue, the main source of all others—a tongue to which, for no adequate reason, the name of Aryan has been given—is likely to turn out a philological heresy. In saying this, let me not be understood to depreciate the valuable, and in many respects original, contributions of Max Müller to the study of philology. But, as has been well said of the remarkable dialogue on language given by Plato, in which Socrates takes so prominent a part, the whole

subject is looked upon with a Grecian eye, from Athens for the stand-point, so has our professor made the Aryan theory the main foundation of the superincumbent structure. The deductions are for the most part reasonable and consistent, but apply only within a narrow range. The multifarious sources of the sequences of language cannot be decided or followed out in the literary sphere alone, but must be sought in facts and observations gathered from all that we know of man in his varied conditions of barbarism and civilization. The late discoveries on and near the Euphrates have furnished irresistible evidence that there existed, long anterior to the Sanscrit, a language wholly distinct in character, not only as to the mode of writing (a fact indeed well known), but in its elementary words, and in its grammatical construction, standing alone. Sufficient materials have now been collected for the publication of a grammar and a dictionary, which will throw much light upon a civilization anterior to Egyptian records, and carry the history of the human race, its culture and its progress, far beyond any of the annals commonly called profane. It is greatly to be regretted, that the explorations of the Holy Land have hitherto furnished few vestiges left before, or even contemporaneous with, the Christian era. The Jews had in them little of an inventive, little of a creative, spirit. The temple which Solomon built was but a feeble reproduction of those grander edifices, the memory of which Moses and his companions had brought with them from Heliopolis, Thebes, and Memphis. No doubt they were gorgeous, but they have left no traces behind.

Whether the old Assyrian tongue was indigenous or not may be a matter of doubt. That it did not belong to any of the Semetic branches seems established. Some reasons have been adduced for giving it an African origin; and it is supposed to have come from Ethiopia, and to have brought with it the civilization and the acquirements which in remote ages flowed northwards with the Nile. Perhaps the theories of emigration and conquest, as accounting for the existence of languages resembling one another, have been pushed too far: frequent intercourse with individuals may account for much which has been attributed to the wandering and settlement of invading races.

We must seek antiquity in popular and unwritten dialects. The language of literature is shifting, but progressive, and has a disposition to accommodate itself to a common classical standard. Etymologies are better traced in the spoken idioms of the people than in the written standards of authorship.

Words are frequently invented by philosophers, very seldom by the multitude. To the authority of Jeremy Bentham we owe some of the most useful words in our language, now generally employed and introduced into Acts of Parliament, as *international*, *codify*, *maximize*, *minimize*, and many others. The rudest languages are usually the oldest. Intercourse modifies the phraseology of literature, whose territory is made up of conquests and concessions. Popular authors are not only creators of new words, but give sanction to old and forgotten ones. It may be said in general, that more than four-fifths of the English tongue are traceable to a Gothic or Anglo-Saxon source. I use Anglo-Saxon in deference to common parlance, but Anglo-Frisian would historically be more correct. In our Lord's Prayer, of 69 words 64 are Anglo-Saxon. In Shakespeare, taking the passage, "To be, or not to be," there are of 82 words 70 Anglo-Saxon. In a passage from Swift, of 88 words, I find 78; of Dr. Johnson, in 87 words, 66 Anglo-Saxon; in one of Addison, of 80 words, 65 Anglo-Saxon; in the Song of Solomon, which Prince Louis Lucien Buonaparte caused to be translated into 17 various dialects of England, the first chapter consists of 327 words, of which only ten are of Latin or French derivation, and there are many verses in which every word is Anglo-Saxon.

Of the non-Saxon words in this chapter, I find in the specimens given the following renderings:

v.	Latin-Eng.	Saxon-Eng.	W. Devon.	E. Devon.	Cornwall.
3	Savour	smell	zaver	sceynt	saavour
	Ointment	salve oil	hointnents	zaaves	aointments
4	Chambers	rooms	chimbers	chimmers	chambers
	Rejoice	take pride	raijjoice	be glad	rejooice
	Remember	reckon	raymembor	think more	raimember
5	Tents	booths	tints	teynts	tents
	Curtains	hangings	kirtins	hangins	coortons
7	Rest	halt	rest	laith	rest
	Companions	fellows	kempanyins	firns	cumrades
8	Tents	huts	taints	teynts	tents
9	Compared	likened	kimpared	laikened	cumpeered
	Company	yoke	kompiny	teams	cumpny
10	Jewels	gems	jewels	spangles	jewels
	Chains	bands	chains	chains	chains
11	Borders	bands	banders	edgins	boerders
16	Pleasant	comely	pleaint	pleasant	pleasunt

In these examples, the West Devon and the Cornish only represent the local pronunciation of the common English text. The Saxon-English and the East Devon supply for the most part non-Saxon with Saxon words. A Devonshire

peasant would assuredly use *smell, salve, reckon, fellows, like,* rather than *savour, ointment, remember, companions, compare.*

In this county, almost every word connected with out-door or field work is Saxon. What *churl* would have understood so grand a term as *agriculture?* Sir Walter Scott, in *Ivanhoe,* remarks, that the very animals' names were Normanized when they reached the tables of "the quality." Swine was turned to pork, sheep to mutton, ox to beef, calf to veal, deer to venison, fowl to pullet: and the passion still spreads; for you do not sit down at a fashionable table now without finding the *Dishes* turned into the *Menu,* and every *plat* bears a name supplied from the French *cuisine.* Our neighbours have made us a slight return—a *biftek, blombodin,* and other such attractive words flourish on the Parisian *cartes.*

Certain languages have now obtained a domineering mastery in the world. Though they have been enriched by new contributions demanded by the ever-growing requirements of knowledge, these requirements will be more and more exacting. The languages that accommodate themselves to the civilization of the times will probably never perish. Among those likely to last as long as the human race endures is our own, planted as it is in every region of the earth, the adopted speech of several of the most populous, prosperous, and progressing nations, and possessing in every department of literature such noble and still augmenting treasures. It will owe its popularity not alone to its wide diffusion, but to its plastic character, and its willingness to welcome whatever is likely to strengthen its efficiency. The passion for "purity," the reference to "dictionaries," and the demand for "classical authority," have been great impediments to the augmentation of the French vocabulary. Corneille was censured for introducing a word so useful as "*invaincu,*" unconquered; but of late years science and fashion have compelled the adoption of many words among our neighbours, in spite of the repugnance of hypercriticism. They have not taken *railway,* but could not do without *rail.* They have *trains, wagons, clubs, steeplechases, jockeys, sweepstakes,* and a multitude besides, which would have been horrors to the Anglo-phobians of old.

The written Chinese, incomparably the most ancient of all existing literary tongues, though most inadequate to represent the present state of literature and science, notwithstanding its claim to 60,000 separate characters, yet may be considered a language removed from the chances of perdition, it being the instrument of the most compact and concentrated third of the family of man. The Russian will probably

absorb the Polish, Bohemian, Illyrian, Servian, and other branches of the Slavonic stem; the Saxon is gradually doing the same with all the local German dialects; the Castilian is driving out the Basque, the Gallician, the Catalan, and other provincial idioms of Spain, as is the Tuscan the local dialects of Italy. In the Philippine Islands two native idioms, the Bisaya and the Tagal, have taken the place of many of the less influential dialects, while the Spanish in its turn will probably supersede them all; and in the process of time it may happen that the acquirement of a dozen languages—a task less laborious than it would seem to be—will open all the portals of knowledge throughout the civilized world. At the present hour we know of the existence of several thousand separate tongues. I do not mean absolutely distinct, but as much divided from one another as the German or Dutch from the English; the French, Spanish, or Italian from the Provençal.

When Rome began its conquering career, the Latin drove out the dialects used by the vanquished. It would be impossible now to form any considerable vocabulary of Etruscan words: those we know have little resemblance to the language of Rome; but of the languages of less civilized tribes, who submitted to the Roman yoke, there is scarcely a tradition, an inscription, or a trace, as there is none of the extinct races of the West India islands.

Had there been much intercourse between England and Ireland, an article of food produced principally in Devonshire and Ulster would not have had two names. The word *laver* is not, I believe, found in our English dictionaries, but the Irish call it *sloch*. Some of our words have wandered far. Burns has:

> "The best laid schemes o' mice an' men,
> Gang aft a-gley" (*or* a-jee).

Local dialects throw much light on the field of natural history; for instance, the rose must have been of comparatively modern introduction into Ireland, Scotland, and Wales, as it bears its foreign name. The apple is *afal* in Welsh, and *uphal* in Gaelic; while grass is in Welsh *wellt*, Gaelic, *feur*. The sloe: Welsh—*Duddraenen;* Gaelic—*Airnag*. Cabbage: Welsh—*Bresych*. Honeysuckle: Welsh—*Gwyddfid;* Gaelic—*Deolag*.

Very rude languages do not distinguish one flower, one tree, one colour from another, except when the flower, the tree, or the colour is connected with some special use for food, for ornament, for exchange, or occupies some wide extent; as

blue for the sky, green for the forest, black for the night, or white for the day. The observation which should mark the various colours of the rainbow would be evidence of progress in the intellect of man.

Taking the most common words in daily use, we thus find no resemblance whatever when we compare the languages of separate races. Except by the merest accident, not a single word will be discovered having the same meaning in any language spoken in the interior of America, for example, and compared with any from the heart of Europe, Asia, or Africa, from Australia, from the islands of the Pacific, or the Indian Ocean.

Craob is the Gaelic generic name for tree; but the Crab-tree is called *Uptal-tiadhain*, or Wild-apple; *Craob-airneag*, the Sloe-tree. *Craob-beite, chuinses, fhigis, fhiona, ghallchad, limoin-mhaelp*, all show that the birch, the quince, the fig, the vine, the walnut, the lemon, the maple, were unknown to the primitive Celts.

Potatoes brought with them their name, and were called *Buntat;* but the Celts soon altered the designation to *Buntaghta*, the precious root. In a sound adapted to another language the derivation is sometimes lost. The Saxonized *Cordwainer* and *Dandelion* do not immediately bring their Norman origin to the mind.

Cabbage in Gaelic is *Cal;* whence kail, colewort. Common cabbage is *Cal cearslach*—round cabbage. Have you had your kail? *An d'fhuaer do chàl?* is the same as asking, Have you had your dinner?

But what a different law applies to languages spoken by tribes of common descent. In these the roots of familiar words are unmistakably to be traced. Such words could not but be preserved, whenever those who spoke them settled, or whenever they wandered. If not evidence of identity of race, they prove similarity of race in a way not to be mistaken. No doubt, where a tribe, small in number, is dispersed among a multitudinous body, their idioms may disappear—swallowed up in a wider sea, as rivers are lost in the ocean. The blacks in the United States, in a second or third generation, lose all traces of the African idioms; but where the gregarious bond is strong enough to link together a mighty clan, or formidable nation, the language will be strong enough for its own support, and will preserve at all events the associations which connect it with the past.

Let me give a few illustrations from the ramifications of the Gothic stem:—

MAN...	*Manna,*	Gothic.	*Mand,*	Danish.
	Man,	A.-Sax., Dutch, Swed.	*Made,*	Icelandic.
	Munn,	German.		

The power of the word *man* is seen by its introduction into many derivations from Latin: ALLE-*mand,* NOR-*mand,* ALLE-*manni,* NOR-*manni;* as well as in Low Breton, *max;* Armoric, *mansh.* It is a part of the Sanscrit word, **MAN***udjah;* of the Latin, HU*man*US.

WATER..	*Wate,*	Mæso-Gothic.	*Vand,*	Danish.
	Water,	Anglo-Saxon.	*Watteu,*	Swedish.
	Weter,	Frisian.	*Vatn,*	Icelandic.
	Wasser,	German.		
WINE...	*Wein,*	Gothic.	*Vin,*	Danish.
	Win,	Anglo-Saxon.	*Vin,*	Swedish.
	Wijn,	Dutch.		
RAIN....	*Rignan,*	Gothic.	*Regne,*	Danish.
	Rinan,	Anglo-Saxon.	*Rigna,*	Icelandic.
	Regenen,	Dutch.	*Regner,*	Swedish.
	Regen,	German.		
KNEE...	*Kniu,*	Maso-Gothic.	*Knie,*	German.
	Knæ,	Norse.	*Knæ,*	Danish.
	Cneow,	Anglo-Saxon.	*Kne,*	Icelandic.
	Knie,	Dutch.	*Knä,*	Swedish.

But to take a word which represents an abstraction—

KNOW...	*Kunna,*	Maso-Gothic.	*Kunna,*	Danish.
	Kanna,	Norse.	*Kenna,*	Icelandic.
	Kunnen,	Anglo-Saxon.	*Kenna,*	Swedish.
	Kennen,	Dutch, Flem., Ger.		

The root, however, may be found in other tongues, whence possibly derived, as

Gna,	Sanscrit.	*Cognoscere,*	Italian.
Gnosco,	Greek.	*Conocer,*	Spanish.
Nosco,	Latin.	*Conhecer,*	Portuguese.

In all these cases there has been intercourse, and the word itself has in it a tone of advancement and civilization.

FATHER..	*Pita,*	Sanscrit.	*Fæder,*	Anglo-Saxon.
	Pater,	Greek, Latin.	*Vader,*	Dutch.
	Athan,	Gaelic.	*Vater,*	German.
	Pader,	Persian.	*Fader,*	Icelandic.
	Padre,	French.	*Fader,*	Swedish.
	Père,	Spanish, Italian.	*Fader,*	Danish.
MOTHER.	*Mater,*	Greek, Latin.	*Mæder,*	Dutch.
	Mada,	Sanscrit.	*Mutter,*	German.
	Madr,	Persian.	*Madre,*	Ital., Span., Port.
	Mat,	Russian.	*Mère,*	French.
	Moder,	Anglo-Saxon.		

All, perhaps, from *ma,* an early utterance.

SUN....	*Sunno,*	Gothic.	***Sonne,***	**German.**
	Sunne,	Anglo-Saxon.	***Soel,***	**Danish.**
	Sunni,	Frisian.	***Sol,***	**Latn., Swd., Frch.**
	Zon,	Dutch.		
STAR....	*Stoerio,*	Maso-Gothic.	*Aster,*	Greek.
	Steorra,	Anglo-Saxon.	*Astrum,*	Latin.
	Ster,	Dutch.	*Astro,*	Ital., Span., Port.
	Stern,	German.	*Astre,*	French.
	Stierne,	Danish.	*Starekt,*	Persian.
	Stjerna,	Swedish.	*Tara,*	Sanscrit.
	Stiarna,	Icelandic.		

This is a word which, in its progress through various languages, has undergone precisely the modifications necessary to adapt it to the peculiarities of each. The combination of the two consonants, *s* and *t*, though so very simple to our organs, is one which is rarely found in any of the ruder idioms of the world.

The remarks which have been made with reference to languages in general—I mean of distinct languages derived from a common source—are equally true of all local dialects. The common words are common to all. The word *man* exists in every one (with the same meaning) of the local dialects of Germany, and they, perhaps, amount to twenty. The word *man* is equally found in every English provincial dialect which has a Saxon origin. Nothing could ever drive it out of our mother-tongue; it belongs to our history; it goes with our laws, with our books, with our songs. A thousand despotic decrees could not eradicate it; a hundred academies would repudiate it vain. It is planted in America, in Asia, in Africa, in Australia, and a noble and emphatic word it is. Come what may, "A man 's a man for a' that."

In tracing the history of languages, we are sometimes embarrassed by the modifications to which they are subjected in that process which introduces their final grammatical forms, and which nothing but education will ever make popular or universal. The persons and the tenses of verbs, for example, will be employed by the Devonshire peasant in the simplest forms: for I *am*, thou *art*, he *is*, we *are*, he will use, I *be*, thou *be*, we, you, they BE. Verbs irregular he makes regular, and says—he *commed*, he *goed*, he *teached*, he *drived*, he *drawed*, he *seed*. He confounds the nominative with the accusative. I heard one day this sentence—"Her axed she about 'en; her telled she her shudd'n du 't; and thof her zed her hath." A boy on Dartmoor, seeing a rabbit, exclaimed, "Hurn! hurn! lookee at the little tail o' en; how he hoppeth."

A conversation is reported between a judge, at the Exeter assizes, and a witness. *Judge*—"What did you see?" *Witness*—"A didn' zee nort vur the pillem." *J.*—"What's pillem?" *W.*—"Not knaw what's pillem? Why, pillem be *mux a-drowed.*" *J.*—"Mux—what's *mux?*" *W.*—"Why, mux be *pillem a-vat.*"

There are many words which in ordinary English are seldom used, but in our Devonian dialects constantly employed; such as *orts* (refuse), *rubble* (rubbish), *quarrel* (pane of glass), *ferroll* (iron or brass ring), *stram* (to bang), *strapping* (big), *swelter* (extreme perspiration), *swinging* (great), *thumping* (large), *tote, tottle* (the whole), *tweedle* (awkward handling), *fardel* (bundle, burden), *withy* (a willow), *corn* (wheat), *ruckee* (to stoop), *pity-hole* (the grave), *settle* (a seat), *belike* (perhaps), *stogged* (stuck in the mud), *bluth* (bloom).

The transformations of some of the commonest words should not be passed over, such as *an't, ban't,* for I have not, am not; *cass'n, cassn't,* cannot; *aye zure,* for yes; *gee,* for go; *whay,* for stop; *nan?* a common interrogation; *I zim,* for it appears to me; *if a za be,* a common concatenation for "in that case;" *lookee de zee,* for attend to me; *thik, thikka, thak, thakka,* this here, and that there. The disappearance of this common word from our language is remarkable, as it is found in ancient writers, from Robert of Gloucester downward, in Wyclif, Chaucer, and in old ballads—

"The chase is lefte for *thilka* daie."

Mispronunciation of letters pervades the local idiom: *o* is turned into *a,* as *stap,* for stop; *rat,* for rot; the French *u* is used for the *oo,* as *stule, fule, spune; y* supersedes *h,* as in *yeth* (heath), *yeard* (heard), or is prefixed to a vowel, as *yemmers* (embers), *yetts* (oats); *v* constantly supplants f, as *vardin, vitty, vur;* and as for the aspirates, they are treated with utter disregard—*ps* replaces *sp,* as *crips, claps, lips, waps; d* in most cases, descending from ancient orthography, stands in stead of *th,* as in *dred, drong, drash, drish* (thrush); *ea* is pronounced *ai,* as *main, craim,* for mean, cream, etc.; the initial *a* is often dropped, as in *'sizes, 'prentice,* and in the children's recital in picking the petals of a flower, "gentleman, *'torney, 'poticary,* thief."

Milton, Spenser, and Shakespeare, South, and Swift, have made our Devonian word *junket* classical;* and, what is still

* "You know there wants no *junkets* at the feast."
Taming of the Shrew. (iii. 2.)
"And bear with you both wine and *juncates* fit."—*Faery Queen.* (ii. 4.)
"The savory *junkets* tasted with delight."—*Drayton.*
"How fairy Mab the *junkets* eat."—*L'Allegro.*

more remarkable, the word is used in old English translations from Virgil, Pliny, and Plutarch. I doubt its commonly-accepted derivation from the Italian *giuncata*, which, like the French *jonchée*, means curds pressed between rushes (*joncs*), like our Bath cheese; and I have the same difficulty in tracing the word *cob* to its source, though we were taught to make our *cob walls* by the Phœnicians, or the Egyptians. The pyramids raised by the Jews on the banks of the Nile are constructed of the same materials; and I may say in passing, that the want of adhesion from the absence of straw, which added so grievously to the labours of the Hebrews of old, has enabled foxes and jerboas to find a retreat in the multitudinous holes with which these wonderful erections are now perforated.

The authors of the *Exmoor Scolding* and *Exmoor Courting* were Andrew Brice and Benjamin Bowring. The former was a learned and laborious bookseller in Exeter, whose folio dictionary was a valuable contribution to the geographical knowledge of his day. The latter (my paternal great-grandfather) was the grandson of a John Bowring of Chumleigh, who was largely engaged in the woollen trade, and coined money for the payment of those he employed. He wrote verses (not of much merit), some of which have been traditionally preserved at Chumleigh, and he was denounced as "a turbulent and seditious person" by the Bishop of Exeter to the Archbishop of Canterbury. No doubt his "little candle flung its beams" in the surrounding obscurity; and he was one of those who "shine bright below, although eclipsed above."

In Devonshire itself there are very many distinct dialects; and words are used in the north which are wholly unknown in the south, and in the east with which the west is unacquainted.

The *Exmoor Courtship* and *Exmoor Scolding* were printed in the *Gentleman's Magazine* for 1746, pp. 297 and 352. There is a vocabulary in the same volume (p. 405) of above three hundred words, which have been transferred to the larger collection.

The dialogues cannot have come from the original author, as an explanation is asked of many of the idioms, and they are given by a correspondent who writes from Exon, Aug. 12, 1746, and signs "Devoniensis."

Perhaps the concluding passage of the *Scolding* is as good an example of the dialect as used a century and half since as can be given. Julian Moreman says: "Labbe, labbe, soze labbe, Gi

o'er, gi o'er, Tamzen. An thee be always agging[1] or veaking,[2] gawing[3] or sherking,[4] blazing[5] or racing, kerping[6] or spaking cutted,[7] chittering or drowing vore o' spalls,[8] purting[9] or glowering,[10] yerring[11] or chounting,[12] taking owl o' won theng or pip o' tather, chocking[13] or pooching,[14] ripping up or round-shaving[15] won t'ether, stivering[16] or grizzeling,[17] tucking or busking, aprill'd[18] or a-muggard,[19] blogging[20] or glumping,[21] rearing[22] or snapping, vrom candle douting[23] to candle teening[24] in the yeaveling[25]—gurt hap else."

A pretty character this for a Devonshire damsel about to be married! Happily, some generations have passed since the picture was drawn.

There is a glossary of 400 words, in the dialect of the West of England, in *Rustic Sketches*, by Mr. G. P. R. Pulman. (1853.) Many of them are not peculiar to Devonshire, and others are mispronunciations of common words; but there are many that are not found in other vocabularies.

The Devonshire dialogues written by Mrs. Gwatkin, the sister of Sir Joshua Reynolds, and published by James F. Palmer in 1857, are rich in local words, and the colloquies are not wanting in dramatic merit. The glossary, though not wholly made up of Devonshire peculiarities, consists of 1000 words, of which by far the greater number are local, but principally collected in North Devon.

Most of the conversational specimens and pieces of poetry which have been published are adaptations of common English to Devonian grammar, or rather, ancient grammatical forms, with spelling representing the vulgar pronunciation. "*The Gospel of S. Matthew*, translated by Mr. Henry Baird into Western English, as spoken in Devonshire," represents the common text as it would be read or repeated by an uninstructed peasant. In Nathan Hogg's poems there are a few genuine provincial words, such as *cocklēērt, dimmet, drat, dyver'd, gawken, hulking, kindiddled, paking, pillamy, raymed, vanty cheeny, vursled, wuck, wap, whacker;* but more might have been advantageously and appropriately introduced.

The names of persons and places in Devonshire would afford instructive materials for volumes, in order to treat the subject in a satisfactory or exhaustive spirit. In whatever

[1] Irritating. [2] Fretting. [3] Scolding. [4] Trying to cheat. [5] Spreading false reports. [6] Finding fault. [7] Speaking out. [8] Casting about accusations. [9] Sulking. [10] Quarrelling. [11] Noisy. [12] Disporting. [13] Hectoring. [14] Making mouths. [15] Chiding. [16] Pretending. [17] Laughing. [18] Soured. [19] Out of humour. [20] Sullen. [21] Sour-looking. [22] Mocking. [23] Extinguishing. [24] Lighting. [25] Evening.

direction the inquiry may be pursued, the predominance of the Anglo-Saxon race and type will be visible.

It is, however, important to premise, that before writing is extensively used and understood, orthography must be undefined, the writer generally adopting the letters which he deems best fitted to convey the sound. There is scarcely an Anglo-Saxon word which is not written in different ways, and there are words which in twenty manuscripts present as many as twenty different modes of orthography. Of the language spoken by our Anglo-Saxon forefathers before the conquest, about one-fifth of the words have been lost, and they have been supplied principally from Norman sources. And independently of the changes of varied orthography, fashion has its sway; and Mrs. Barker, in her Northamptonshire Glossary, gives a curious specimen of the aristocratical changes of language, from dad, mam, and porridge, to father, mother, and broth; next, papa, mamma, and soup.

More than nine-tenths of the family proper names in Devonshire are Anglo-Saxon. Among the inhabitants of our small towns and villages there will scarcely be found any Norman, Celtic, or foreign names, as the present residents are mostly descendants of the original settlers. There is little emigration into obscure localities; but as towns and cities become prosperous and productive, they invite strangers to fix themselves, and the population loses much of its normal character by the infusion of new elements. Half a century ago a Greek or Indian name would scarcely be found in the London Directory; they are there now by hundreds; while Germans, of whom few were settled among us in ancient time, may be counted by thousands. But of all migrating nations ours is the most migratory, and our language is spoken over an incomparably larger extent of territory, and in a far greater variety of latitude, than any other tongue.

The immense preponderance of Anglo-Saxon names applies only to the less privileged (sometimes called the middle, or the lower) classes; for when we come into the field of the nobility and the aristocracy there is a great infusion of Norman names, such as Courtenay (Short-nose), Fortescue (Strong-shield), St. Maur (Seymour), Fitzroy (King's Son), Grosvenor (Great-huntsman), Neville (Newton), Beauclerc (Fine-writer), and a multitude besides. It has from my boyhood been one of my amusements to look, in passing through our streets, at the names of the different shopkeepers, and I have found less than one in ten derived from any but an Anglo-Saxon source. Migrations might be easily traced by studying

directories. One of the very commonest names in London is *Evans*. The race took their departure from Wales. The Macs and the O's would help to show how many of the Caledonians and Hibernians have honoured the English by settling among them.

All the 32 hundreds, 2 boroughs, and 1 city of Devonshire bear Saxon names, with the single exception of Hightor, if Tor is to be traced to a higher antiquity: at all events, it is joined to a Saxon adjective. Thirteen of the hundreds have the termination of *town;* viz., Bamp, Torring, Braun, Clyst, Coly, Credi, Erming, Freming, Halber, Lif, Molt, Plym, Taw, Tiver-*ton*, most of them representing the principal adjacent streams or rivers. Two are ecclesiastical—Ax and Ex-*minster*. There are three *leighs* (fields)—East Bud, West Bud, and Wink-*leigh;* three *ridges*—Cole, Hay, and With-*ridge;* one Hart-*land;* one Hem-*yock* (Saxon for uncleaned wool); one *Saint* Mary of Ottery; two *boroughs*—Ro and Star; one Sheb-*bear;* one Sher-*will* (perhaps well); one Teign-*bridge;* one Won-*ford;* one *port*—Devon; one *mouth*—Plym; while Exeter has conveyed its name of Roman origin from Isca, Exonia to Exeancester, Exon, Exeter.

The remarks that apply to the greater divisions of the county may be repeated as regards both the smaller districts and the towns, villages, hamlets, and other localities. Everywhere the Gothic or Anglo-Saxon element is predominant.

Of characteristic adjectives prefixed to localities there are 79 *high* and *higher*, 79 *low* and *lower*. There are 97 *wests*, 72 *easts*, 68 *souths*, and 47 *norths*. There are 35 *up* and *uppers*, of which 15 *upcotes*, 7 *unders*. There are 30 *littles* and 20 *greats*.

The directory published in 1856 gives the list of more than four thousand localities in Devonshire bearing Anglo-Saxon names. I scarcely discover a hundred traceable to Celtic, Roman, Scandinavian, or French origin. *Pen* and *tor* are sometimes, but rarely, found. *Tor* is generally traced in our dictionaries to an Anglo-Saxon origin. In Gaelic, however, it is found in the oldest records, both of prose and poetry, spelt *torr*. In Welsh and Armoric it is *twr* and *twrr*. Pliny mentions *dyr* as a Mauritanian word for Mount Atlas. *Taurus* is the same designation Latinized in Asia: it gives names to places among the Arabs; as, for example, *Tour*, an elevated spot in the Gulf of Suez. In Norway it is the name of one of the highest mountains. It is found—accommodated to the language—in Spain, Italy, France, and several other European countries—in the ancient Chaldee and in

the modern Persian. There are few words of so great an antiquity and so wide a diffusion. It is seen in all the branches of the Gothic stem.

Avon, the widely-spread Celtic for river, only once occurs, as far as I know, in Devonian names of places; and *tre*, the Cornish for town, though so common on the other side of the Tamar, is scarcely known in Devon. The same may be said of *pol* and *pen*. *Pether* has been cited as a Cornish word from *peth* (riches), but its derivation is more probably Saxon; and few are the traces left among them by the invading Normans of their presence or progress.

In the neighbouring county of Cornwall a rich vocabulary may be found of persons and of places bearing British names, though even there many words have been Saxonized by time, and the English language has been universally introduced; not the local dialect of our own neighbouring county, but the English of the more educated classes.

The most common termination is *ton*, or town (in Anglo-Saxon *tun*), which is affixed to no less than 380 different localities; and it is obvious that this word would be the first fixed upon where there was any considerable gathering of people; but it is sometimes applied even to a single dwelling or farm.

Next in importance is *combe* (valley). There are in Devonshire 31 Combes without any other designation; with Combe as a prefix, 21; while to 200 places Combe as a postfix is attached.

Though *combe* is a pure Saxon word, it nearly resembles in sound and meaning the *cwm* of the Welsh, from which it has been supposed to be derived. The word never once occurs in Shakespeare, nor does *tor*.

The word which stands third in rank, and which naturally became of great interest to a growing population, is *Ford* (Anglo-Saxon unchanged), by which no less than 220 localities are designated, having some other word attached; but there are 19 places called Ford, besides 5 Forders and 2 Fordas.

Bridges are, of course, fewer in number than *Fords*, and more modern in their introduction. The term *ford* occurs seven times more frequently than bridge; but the building of a bridge would not, in many cases, alter the name of the locality, though such additions as Ford-bridge, or Bridge-ford, would very naturally occur.

Cot—probably adopted where there was a single small house on the spot—occurs 212 times.

Land, or *lands* (Anglo-Saxon), is connected with 190

localities. It is one of the words running through all the ramifications of the Gothic root, and has served to initiate and make acceptable a new word—*Fatherland*, which we have borrowed from the Germans, and which sounds far more sweetly than *country*, which is adopted from the Normans. Lover says, very emphatically, referring to the heroism of our male ancestors and the garrulity of our ladies,

> "On every hand
> We trace our blessings whence they sprung;
> We call our country *fatherland*,
> We call our language mother-tongue."

Leigh, or *lea* (*ley*, Saxon), a very pretty word, which is familiar from Gray's line—

> "The lowing herd winds slowly o'er the lea,"

occurs, with its adjuncts, 30 times, and as a postfix 170, in Devonian localities. Shakespeare attaches to it a characteristic adjective—"the plough-torn lea."

There are 23 places bearing the name of *down*, or *downs* (*dun*, Saxon), and 142 having *down*, or *don*, for their terminal. How many of these ancient *downs* are now cultivated land would be an interesting inquiry, and much assisted by the name that once characterized them.

There are 6 places called simply *wood* (*wude*, Anglo-Saxon), 58 *Woods* with postfixes, of which 8 are *Woodlands*, and 41 in which the wood follows some other title.

Well, or *wells* (*well*, Anglo-Saxon), is attached to no less than 104 names, all denoting the original presence of water, and which would be probably found still to entitle them to their old designation. Among the *wells* are 6 called holy; to some of them miraculous virtues are attributed, though they bear no sainted name. Parker's Well, near Exeter, was supposed to cure all diseases of the eyes—a mere exaggeration of the wholesome effects of washing from a pure stream.

There are 95 *hams* (Anglo-Saxon, *wam*) in Devonshire; a word which is spread over the whole of England, giving a name to several counties, and to many large cities and towns, yet is now seldom employed in colloquial discourse.

Berry, *bury*, or *burg* (*burg*, Anglo-Saxon), town, is found in 80 places, of which the greater part no longer would be entitled to the distinction, but have fallen into obscurity.

Stone (*stan*, Anglo-Saxon) was a natural indication of a locality. Four places have the naked name, 8 have appropriate adjuncts, which serve to distinguish them, as Stone-

combe, cross, ford, haye, house, land, leigh, and moor, besides which there are 68 places of which stone is the termination.

There are 9 solitary *hills* (*hil*, Anglo-Saxon), and the same number with adjuncts, besides 56 places of which hill is the characteristic ending.

Of *haye*, or *hayes*, there are 54. This may be a softened sound of the Saxon hedge (*hedjian*), or an introduction of the Norman word. In the neighbourhood of cities and towns it has the French meaning. In Exeter it is associated with both Saxon and Norman adjectives—Northernhay, Southernhay, Friernhay, Bowhay, Shilhay, Linhay, and others. *Haye* is not found in Johnson's or Walker's dictionary.

Ridge terminates the name of 38 localities.

Bere, or *beare*, sometimes stands alone. It is found in the beginning, but more frequently as the last syllable, of localities. In this position it occurs 30 times. There are 5 Larkbeares in Devonshire. It is written Larrocbere in Doomsday Book.

Bridge, *moor*, and *brook* (*brudge*, *moer*, *brok*, Anglo-Saxon) occur each 30 times in the names of places; *mill* (*milk*, Anglo-Saxon) 22 times; *thorn* (*thorn*, Anglo-Saxon) 18 times; *park* (*pearrne*, Anglo-Saxon; *parc*, Norman) 15 times. We have 14 *pits* (*pit*, Saxon), 10 *holes* (*hol*, Saxon), 10 *knolls* (*knolle*, Saxon).

Besides these, the following terminations are most common, and their almost exclusively Saxon character needs not to be specialized:—Bourne or burn, cliff, court, croft, cross, dale, dean, furze, gate, glebe, hayne, head, lake, lane, leet, marsh, mead, mere, mouth, oak, pool, quay, spring, stok, stoke, stowe, tree, vale, venn, way, week, worth, and worthy. A termination only once, or very seldom occurring, I do not at all quote.

Compared with Cornwall, the number of saints giving names to localities is rare. St. Andrew, St. Ann, St. Brannock, St. Brideaux (with whose history I am unacquainted), St. George, St. Giles, St. John, St. Mary, and St. Petrock are the only ones figuring in the index. But though there are not many saints, monks, abbots and bishops are not wanting.

The probability is, that most of our localities had their designations anterior to the introduction of Christianity. The rarity of Norman names is confirmatory of the anterior introduction of Saxon words.

Christianity, and the zeal of early missionaries, introduced many ecclesiastical terms, not only connected with church ceremonials, but with forms of belief. Religion, orthodoxy, and many besides, remain unchanged; some such, as faith, church, creed, and others, accommodated themselves to Saxon forms.

All languages have to draw on other languages for novelties, introduced by intercourse with nations abroad, or by inventors at home. The Welsh, for example, took *port* and *awr* (bridge and gold) from the Romans; the Biscayans *latigua* and *candela* from the Spaniards. The English and the Dutch have given many words to other nations connected with shipping, the French connected with military matters. Articles of commerce frequently point out the regions whence they came.

The three most prominent of Norman names in Devonshire are *court, haye,* and *villa.* Yet *curt* is the Saxon for palace. *Haye* is not necessarily Norman. *Villa* alone is distinctly traceable to the Latin and the French, and it is of rare occurrence.

Many of the Devonian names would open the door to curious and interesting speculations, not alone in geography and etymology, but in ethnology and natural history. We have, for example, no less than 13 Bucklands; no doubt places distinguished for herds of deer. In the 7000 localities which constitute the London district the name only occurs twice, and then appropriated to villa and street, being probably the application of a family name.

We have 23 *Bartons*, the ancient meaning of which was the farm or outhouses attached to larger seats or properties. There is but one Barton* (a street) in the London district. We have four places bearing the ancient title of *Yeo* standing alone, and six more to which Yeo is the prefix (whence yeoman). The origin of this word has led to much controversy. Giman is the Frisian for villager. Guma and Zuma are Gothic and Anglo-Saxon for countryman. The word is not found in the London district, except as applied to two modern rows. We have nine *Burrows*, most of which have been deserted by the conies.

If a vocabulary were constructed to consist only of local Devonian words—meaning words not found in the English dictionaries—of words which, though found in them, have a peculiar local meaning—and of words whose form and pronunciation are so unlike our common English as not to be intelligible to Englishmen in general, that vocabulary would consist of nearly 2000 words.

Of words purely local, such as *mors, tallet, plid, crub, bucked, prilled, bosky, claggy, squinch, gammet, therle, sticked,* a list of nearly a thousand might be collected.

* The word is Anglo-Saxon—*Bere-tun*, and is found in Todd's Johnson.

Then such as bear a local and peculiar meaning—*agreeable* (consenting); *cruel* and *mortal* (very), as *cruel hard, mortal kind; power, sight,* and *world* (much or many); *power* of money; *sight* of people; *world* of good; *reckon* and *guess* (which have been transferred, with their Saxon meaning, to the United States); *dogs' ears* (crumpled leaves); and multitudes besides used in Devonshire in a sense different from that they bear elsewhere.

Take, as specimens of mispronunciation, *gurt, hood, vath, rail, vammish, gulk, slimpole,* and who would discern in them great, wood, faith, revel, ravenous, gulp, simpleton. No sentence of half a dozen words uttered by a countryman but will give examples of these peculiarities.

"There bė the mune;
Us can't get tu 'n,"

is a popular joke.

Ancient terminals preserved in Devonshire, such as *stonen, housen, ourn, yourn,* are also worth notice; as is also the superfluity of words having the same meaning, as *pulking, lamming, strapping, swinging, thumping, wopping, walloping,* all meaning, when applied to a man, a stout, coarse fellow. *Why vor?* is a more sensible inquiry than Wherefore? and the verbs, to *gooden,* to *wossen,* and to *bettern,* are more intelligible to the people than, to prosper, to deteriorate, and to ameliorate. There is much tenderness in the supplicatory forms *du 'ee, don't 'ee,* and heartiness in the *gude, now! gude, zure!* with which a pleasant announcement is welcomed. *Never the near,* is an amusing form of To no purpose.

The practice of swearing is in most languages modified by timid instead of outspoken oaths. They remind us of the apology of the girl who said that her illegitimate child was only a very little one. Devonshire has *Begorz,* instead of By God! *O Jaykle!*—O Jesus! *Odd's wenderkins*—God's wounds. *Odd dang it, Odd rabbit,* for God damn it! and many more. The forms of abuse are often amusing. A scold is called a *rant-a-come-scour,* or a *hawk-a-mouth-toub;* a large-eyed person, *sasser-eyes;* a fool, a *drumble-drone, dunderhead;* a weak child, *nestle-dreft. Botheration,* is said to be dinning into two ears at once—both-ear-ation; *cauchee-pawed,* left-handed; *chill-bladders,* chilblains; *wash-a-mouth,* a blab; *wink-a-puts,* a fool; *zour-zwapped,* crabbed; *mulli-grubs,* bad temper; *mumchance,* a silly, silent person; *moody-hearted,* melancholy; *clapper-claw,* a noisy woman; *doldrums,* ill-humour, sometimes the death-pang; *draggle-tail,* a slut;

grizzle-de-mundy, a laughing zany; *kick-hammer*, a stammerer; *labb-o'-the-tongue*, a tittletattler.

But the field of inquiry is as wide as it is interesting, and in it there is much to explore. It would be well if, in the writings of Cædmon, Beowulf, Bede the Saxon chronicler, and any literary remains anterior to the Norman conquest, the words were selected which, lost to the general English language, are preserved in our localities; and the study might be pursued through Chaucer, Spenser, Shakespeare, and the early dramatists; such, for example, as *micher* and *miching*, *junket* and *junketting*, and very many more such.

> "Then will I lay out all my larderie
> Of cheese, of cracknells, curds, and *clouted* cream." *

Ancient ballads, like

> "Haven't ye heard of Lydford law,
> Where in the morning they hang and draw,
> And sit in judgment after?"

Devonian sports would form another topic; among them "*Riding Skymaton*," as described in Hudibras, b. ii., can. 2. In the *Notes and Queries*, iv. 951, is a humourous account of an exhibition of the sort at Charing Cross, in 1737.

Prisoner's bars and prisoner's base, apple-pie beds, bandys, out-hurling, hobby-horse, by which at Combemartin they are said to commemorate the tradition of the wild man of the woods.

Finally, local traditions, proverbs; such as the description of a bad choice of a wife—"A goed to the hood, and a got a crooked steck;" quaint sayings, as "Muxen up to the Huxen." Poetical scraps would be well worth collecting and preserving, as

> "When Ex'ter was a *vuzzy* down,
> *Kirton* was a market town."

> "When Haldown has a hat,
> Let Kentown beware a *skatt*."

> "Clouds upon Haldon bring showers to Kenton."

The traditional cession by the Duke of Lancaster—

> "I, John of Gaunt,
> Do give a grant,
> Hatherleigh Moor
> To Hatherleigh poor,
> To have and to hold for evermore."

* Barnfield's "Affectionate Shepherdess" (1594), quoted by Palmer, p. 36.

Again—

"He that will not merry be
With a pretty girl by the fire,
I wish he was a-top of Dartemoor
A-*stogged* in the mire."

Description of a day's meals in Devonshire—

"Stay-bit and breakast, *ammot* and dinner,
Mumpit and crumpet, and a bit arter supper."

"Rain, rain, go to Spain;
Never, never come again.
When I brew, and when I bake,
You shall have a *figgy* cake." (plum pudding.)

"A Joliphant ride,
Two dames on a horse, and neither astride."

Superstitions, such as the Exmoor charm for curing sciatica—

"*Bone shave* right,
Bone shave straight;
As the water runs by the stave,
Good for bone shave."

Or for nettle stings—

"In dock, out nettle;
Out nettle, in dock."

The belief in the *Yeth-hounds* (headless dogs) being the spirits of unbaptized children was widely spread in North Devon a generation ago. *Pixies* present a topic very insufficiently explored, as do *Gallitraps*, the mysterious circles, into which any guilty person having trod is doomed to be delivered over to justice.

Devonshire may well lament the want of a tolerable county history; but whenever such a history is properly written, the local dialect, and its many associations, will afford materials for a most instructive and amusing chapter.

ON THE PRINCIPLE OF RHYTHM, AS APPLIED TO ENGLISH VERSE.

BY THOMAS FOSTER BARHAM, M.B.

THOUGH the mechanism of English verse is not founded principally on the distinction of syllabic quantity, like that of the ancients, but on the variation of accentual emphasis, yet it would be a great mistake to suppose either that it is destitute of rhythm, or that rhythm is not with us precisely the same principle which regulated the recitation of the classical metres.

The principle of rhythm is a thing inherent in our nature: it is the principle of *keeping time.* Its most rudimentary development leads us to observe uniform intervals even in the repetition of single strokes, as in the tolling of a bell. But as the word rhythm involves a reference to *number* or *counting,* we do not in general apply it to cases of this kind, but only in those in which the movements, or sounds, are arranged in successive sequences or groups, recurring over and over again, in a set time and order. Such we observe in ringing peals, in dancing, rowing, and musical performances in general. In all these instances the observance of time seems to proceed from a natural instinct, felt both by the cultured and the rude, and universally obeyed, more or less, in practice.

The observance of rhythm in *verse* lies, therefore, in reciting it with a regular keeping of time, somewhat as in music, though not altogether so strict and exact. The *syllables* of the metre must be taken as *notes* of various lengths; the successive *feet* in which they are contained must be taken as *bars;* and these must be uttered in *equal* spaces of time. This observance of time must in effect be maintained by a *uniform counting,* either actually performed, or mentally underheard, of some certain number, as 2, 3, 4, or 6, to each foot or bar. And with this counting, the arrangement of the *syllables within the foot* must have some regular correspondence, according to the nature of the metre.

Such being the nature of metrical time, it is the office of

rhythm to maintain the steady and uniform observance of it. In the discharge of this duty, modern nations in general, and our own as much as any, have been so lax and negligent, that in this, as in most other branches of the fine arts, we are driven to sit as scholars at the feet of the ancients. The accuracy of their ears obliged them to cultivate the due observance of metrical time by help of a *mechanical process*, not unlike that which we now employ in musical concerts. It was the *alternate rise and fall of the foot*, or *hand*, corresponding with each successive foot, or syzygy, of the metre. The raising of the foot they called the *arsis*, the setting it down the *thesis;* the former naturally being *without sound*, and the latter *with sound;* by which sound they said that the time of the metre was *struck*, or *beaten*. Accordingly they said, "that *rhythm consisted of arsis and thesis, together with keeping of time*."*

Now, I apprehend, that all this doctrine of rhythm, though certainly pretty much ignored and neglected by us, applies as truly and usefully to English metres as it did to the Hellenic, or the Roman. Why should it not? Our metres consist of the same elements as theirs, that is, *syllables varying in time and tone*, and our actual delight in music is surely a proof that we are not less sensible than they were of the charm of regular time. I do not, indeed, mean to say that the use of the aforesaid mechanical process of rhythm is in general required in the simple recitation of verse. But that regular observance of *time*, which it was intended to secure, *is* needed, or at least desirable; and to this end, in training an unpractised ear, the mechanical aid of *arsis* and *thesis* will be found useful. It will both give the reciter a due conception of what he ought to aim at, and likewise assist him in attaining it.

Now there is a notion abroad, that the proper reading of *English* verse requires no attention to *syllabic time:* in other words, that the distinction of *long* and *short syllables* has nothing to do with it; and that, prosodially considered, our syllables differ only in being *accented or unaccented*. I believe this opinion to be, in point of fact, decidedly an error. Doubtless, a slovenly and slipshod way of reading verse, in which a proper regard to syllabic time is very little apparent, is common enough. But it is not those who read in this way that give to poetry its power and its music. In *their* mouths verse is either hardly distinguishable from prose, or degenerates into a monotonous chant. When verse is read by one

* Baccheios.

who knows what verse should be, and understands the power of rhythm, an effect will be produced of which all will be sensible, though few will understand the cause.

Without an observance of the distinctions of syllabic time there can, in fact, be no true rhythm, and therefore no *metre* that deserves the name. For the ancients rightly said:—"*Rhythm may be without metre, but metre cannot be without rhythm.*"* Of what use would it be to count the time of musical bars, if the notes which they contained had no definite value in time, and were neither quavers, nor crotchets, nor minims? The case is the same with the syllables which form the feet of verse. Unless they have a definite value in time there can be no counting of the bar, and therefore no rhythm; in other words, no real observance of metrical time, or display of the proper nature and power of verse.

It behoves, then, both the makers and the reciters of English verse to pay a due regard to the requisite distinction of *quantity* in the syllables, if they desire it to have that grace and power of which it is capable. This, indeed, is not so imperatively necessary, nor to be exacted by so strict a law, as in classical verse; because, as already observed, this distinction is not with us the principal basis of the structure of metre. But though the order of long and short syllables *within the foot* admits with us of more licence, still it is by no means a matter of indifference; and unless it be in a fair measure regarded, the verse will never exhibit those qualities of smoothness or strength, grace or dignity, which are essential to poetic beauty. And especially is it necessary that the collective *time* of the *entire foot* or *bar* should always be sustained with the requisite amount of syllabic quantity. If it be defective in one syllable, it should be made up in another. Otherwise the rhythm must inevitably be greatly impaired, and the lines be made either feeble and trivial, or heavy and laborious. Of the one, *Cowper* gives us a specimen in such a line as this—

Still making *probability* your clue;

where the word *probability* has five consecutive short syllables: and of the other, *Pope*, intentionally,

When Ajax strives some rock's vast weight to throw,

the line, too, labours, and the words move slow.

I will now endeavour briefly to indicate the mode of applying rhythm to the several leading forms of our English metres, agreeably to the method of the ancients. These forms

* Maximus Victorinus.

are essentially *two*, according as the foot consists of *two* or of *three* syllables. I may, therefore, call them the *dissyllabic* and *trisyllabic* tissues.

In the *dissyllabic* tissue—which, when the line begins with the *short* or *unaccented* syllable, is called *iambic;* and when with the *long* or *accented* syllable, *trochaic*—the rhythmical bar comprises *two trochaic feet*—counting the number 6; that is, 3 to each *arsis*, and as many to each *thesis*. In the following *iambic* lines of Pope the rhythmical bars are marked on this principle—the arsis thus :, the thesis thus | .

Awake, my St. John! leave all meaner things —
: | : | : |
To low ambition, and the pride of kings. —
: | : | : |
Let us, since life can little more supply —
: | : | : |
Than just to look about us, and to die, —
: | : | : |
Expatiate free o'er all this scene of man; —
: | : | : |
A mighty maze, but not without a plan. —
: | : | : |

I may here make one or two observations tending to show the function or use of the rhythm. Beside keeping the time correct and steady throughout, it helps us to detect, and as far as possible amend, notable defects of quantity occurring in certain places of the metre. Thus, in the second and fourth of these lines, the quantity in the first thesis is deficient, and requires to be prolonged by the reader in the utterance.

Again, we may observe that this, our common ten-syllable metre, is incomplete, and when rhythmically read, requires a short pause to fill the vacant thesis at the end of each line. The complete metre, which we call the Alexandrine, has twelve syllables, as we see in the second line of the following couplet:

"The air, such sweetness loth to lose,
With thousand echoes still prolongs each heavenly close."
: | : | : |

A pause of the same kind will be required by the rhythm in our common ballad stanza, at the ends of the short lines.

"To hunt the deer, with hound and horn,
: | : |
Earl Percy took his way. —
: | : |
The child may rue, that is unborn,
: | : |
The hunting of that day." —
: | : |

In other cases the rhythm will teach us to supply the want of a final syllable by prolonging a previous syllable.

> "'Twas when the seas were roaring,
> With hollow blasts of wind,
> A damsel lay deploring,
> All on a rock reclined."

The rhythm here has room for an additional syllable, as if it had been written, *roaring loud.* Other cases will occur in which the rhythm will teach us to give to single syllables the length of entire feet.

> "For auld lang syne, my dear,
> For auld lang syne; —
> We'll tak' a cup of kindness yet
> For auld lang syne." —

Trochaic verse differs from iambic only in commencing with the long or emphatic syllable, instead of the short one. The metrical tissue, and consequently the rhythm, is exactly the same. Dryden supplies us with a beautiful specimen :—

> Softly sweet in Lydian measures,
> Soon he soothéd his soul to pleasures.
> War, he sang, is toil and trouble;
> Honour but an empty bubble:
> Never ending, still beginning,
> Fighting still, and still destroying;
> If the world be worth thy winning,
> Think, O think it worth enjoying.

We come now to the *trisyllabic* tissue, in which there prevails an alternation on *one long syllable* with *two short ones.* In the *Anapæstic* form the *latter* take the lead. The rhythm is marked on every third syllable.

> "At the close of the day, when the hamlet is still,
> And mortals the sweets of forgetfulness prove;
> When nought but the torrent is heard on the hill,
> And nought but the nightingale's song in the grove."

In the *Dactylic* form the *long syllable* leads the line. Each foot forms here a bar, counting four.

> "Erin, the tear and the smile in thine eyes
> Blend like the rainbow that hangs in the skies;
> Shining through sorrow's stream,
> Saddening through pleasure's beam,
> Thy suns, with doubtful gleam,
> Weep while they rise."

To this class belongs also the famous ancient *epic*, or *dactylic hexameter*, which several eminent writers have of late attempted to introduce into our poetry, but, as I believe is generally admitted, without much success. The cause of their failure appears to me sufficiently obvious. They have constructed their hexameters entirely on the modern accentual system, and thus substituted for that rich and ever-varying accentual melody, which is the charm of Homer and Virgil, a dull and wearisome monotony, which has no charm at all.

The rhythmical treatment applied to the foregoing specimens will, I think, pretty well illustrate that which is required in the other forms of English metre. One further remark is applicable to them all; namely, that wherever a *stop* or *pause* is required by the sense in the course of a line or metre, a corresponding suspension will be required in the rhythm—the *sense* overruling the *sound*. Thus—

> "To be, or not to be—that is the question."

The only end which these brief and imperfect hints, on so extensive a subject as metrical rhythm, can answer, is, possibly, to awaken in some minds such attention as may lead to a further study of it. As allied, on one hand, to the natural history of man, and, on the other, to a most noble art, I hope that it will not be deemed foreign to the objects of our Association. I cannot but think that the metrical art is at present treated too empirically among us, and that practical benefit would arise, both to the writers and readers of English poetry, if more attention were directed to the principles on which its versification is founded.

CELTIC REMAINS ON DARTMOOR.

BY JOHN KELLY.

On the western borders of Dartmoor, verging upon the present cultivated districts, are numerous vestiges of ancient people. Within an area of six or seven miles, and at a short distance from Plymouth, are hundreds of these remains, consisting of Hut Circles, Sacred Circles, Barrows, Kistvaens, Cromlechs, and Cairns.

Hut Circles.—The Hut Circles (as being most numerous, are first mentioned) are for the most part placed on slopes, facing either the south or west, and are of various dimensions, ranging from 10 to 30 feet in diameter; some insulated, but more commonly in clusters or groups, of from 4 or 5, to 30, and upwards. They are formed of stones gathered from the surrounding Moor, loosely thrown together, and are about 3 or 4 feet in height. Each hut has an entrance, or doorway, formed by placing two large slabs on their ends; they are conjectured to have been completed for habitation by erecting poles on the circular basements, brought together at the top, and either covered with turf or thatched with rushes. There are some "Beehive Huts," but these are not numerous, and are composed entirely of stones overlapping each other, and forming a flattened cone. They are intermingled with the Hut Circles, but are so small, only 7 or 8 feet in diameter, that they do not seem to be well adapted for habitation, and were probably storehouses or something of the kind. These groups are in most instances surrounded by a rude fence, either circular or oval, about 6 feet in height, and formed of the same materials, and in the same manner as the Hut Circles.

The Hut Circles on Dartmoor, spoken of by Rowe in his perambulation of the Moor as aboriginal towns or villages, and the remains in connection with them, are supposed by him to be Druidical; it is, however, to be observed of those in this neighbourhood, that ancient Tin Stream Works are their invariable accompaniment, though this does not

necessarily take from their antiquity, and the persons working them may have been observers of the Druidical form of worship. Along the banks of every stream there is undeniable evidence that the ground has been worked for tin, and in every instance these Hut Circles are in close approximation. The Circle is the prevailing form of the Huts; but there are some exceptions, which will be subsequently noticed.

Kistvaens.—There are only two Kistvaens in this neighbourhood, as far as is yet known; one on the Erm, on the east side of the stream, near Lower Piles Wall, about a mile above Harford Church; the other in Langcombe Bottom, between Yealm Head and Plym Steps, on the right bank of the valley; both have been disturbed. As far as has yet been discovered, there are three Sacred Circles; one on the west bank of the Erme, at some distance above the river, on the south-east part of Stall Moor; another at Cholwich Town; and a third near Trolsworthy Tor, on the Plym.

Rectangular Buildings.—Four Rectangular Buildings have been found, two on the Erme, and two on the Yealm.* Of those on the Erme, one is in a small ravine, near the Sacred Circle on Stall Moor; the other on the opposite bank of the river, and at no great distance from the first. On the Yealm, one is a little above the waterfall near Yealm Head, on the west bank of the stream; the other at a short distance below it, on the eastern bank. All are close to the streams, while the Hut Circles are in more elevated positions.

In the construction of these Rectangular Buildings, more care has been bestowed than in that of the Hut Circles, the stones having been laid in courses, having the interstices filled with earth; and some of the stones appear to have been roughly worked. In one of those on the Yealm is a dwarf wall about 18 inches high, reaching nearly across the hut. In that on the east bank of the river was found an oblong worked stone (granite), about 3 feet in height, by 20 inches in breadth, and 3 or 4 inches thick, having in it two cavities, about 12 or 14 inches long, 4 or 5 inches wide, and 2 inches deep, at right angles to each other; and part of a similar stone was found in the hut on the west bank of the river. In the present stage of information, it would not, perhaps, be safe to hazard an opinion to what purposes these stones may have been applied; but it is not altogether improbable (as they were evidently connected with the stream works) that they might have been moulds for casting ingots of tin; why

* Two also exist on the Walkham, above Merivale Bridge.

they should be found in the Rectangular Buildings only future enquiries may solve.*

The Kistvaen is composed of five slabs, two forming the sides about 4 feet in length, and 18 inches deep; two forming the ends, and one the cover. It stands on the surface of the ground, and resembles a rude tomb; it is enclosed in a circle of stones, set on their ends, 3 or 4 feet high, and about 8 or 10 feet in diameter, and is admitted to be a place of Sepulture.

Sacred Circles.—As far as is yet known, there are three Sacred Circles; one on the west bank of the Erme, on the S.E. part of Stall Moor; another at Cholwich Town; and a third near Trolsworthy Tor, on the Plym.

The Sacred Circle is from 20 to 30 feet in diameter, and is formed in the same way as the circle round the Kistvaen, but of stones of a larger size. In connection with the one on the Erme, commencing at and leading from it, in a straight line, and extending eastward about half a mile, is a single row of stones, of a less size than those forming the circle; and it is understood that similar rows of stones are attached to the others.

They are stated by Rowe to be places set apart for the performance of Druidical religious ceremonies, an error which seems to be commonly prevalent; but in the explorations of the Castle Howard tumuli, in Northumberland, by the Rev. Mr. Greenwell, of Durham, among which similar circles occur, sunk Kistvaens were discovered in the enclosure, containing human remains—beads, urns, flints, &c.; and it will probably prove that these in this neighbourhood are also places of sepulture, and contain similar relics.

Barrows.—The Barrows are of considerable magnitude, 20 feet high, and 40 or 50 in diameter. They are conspicuously placed upon the crests of the hills, and are composed of loose stones of such a size as could be conveniently carried by a man. They are believed to be places of burial of chiefs, or persons of eminence; but although some of them have been opened, nothing of a sepulchral description has been found, though this probably arises from the examination not having been made with sufficient care; in fact, the explorers have

* In one of the Rectangular Buildings examined this summer by Mr. Spence Bate, there was found, besides two granite stones, in which supposed moulds of different shapes and forms had been cut, a place that was undoubtedly the remains of a furnace, from which a flue passed away to one of the corners in the outer wall.

not gone below the surface of the soil upon which the Barrow rests.

Cairns.—The Cairns are similar to the Barrows, but smaller, and in some instances hollow.

That all the objects in this neighbourhood are of great antiquity there is no reason to doubt, but of what particular "period" has not yet been determined, no relics having been yet discovered, nor, except in one or two instances, has any search been made.

If it be admitted that the people were tinners, they were probably acquainted with copper, and the "bronze period" may then be the one to which they belong; that they were in possession of metal tools, the sinking of the hollows in the stones before referred to is strong evidence.

As similar remains of habitations have been discovered in many parts of England, Scotland, and Wales, those on Dartmoor are, no doubt, the type of the dwelling places of the ancient inhabitants of this country. Constructed of different materials in different localities, they appear to be alike in their general plan, varying only in the materials of which they are composed. Where earth was most convenient, they, as well as the Tumuli or Barrows, were constructed of earth; and where stone was plentiful and available, as on Dartmoor, recourse would naturally be had to that material.

With such a field for investigation as is offered in this immediate neighbourhood, it is hoped that another summer will not be allowed to pass without an examination of these long neglected remains, which, from what has occurred in other places, will, it is believed, be attended with satisfactory results.

The Rev. Mr. Greenwell, before referred to, has been communicated with, and he is decidedly of opinion that these objects, if examined with proper care, will be found to contain relics of their ancient occupiers.

A small subscription, say 5s., if only 20 or 30 persons should contribute, would suffice for a fund to begin with; and surely there can be no difficulty in finding, in Plymouth and its neighbourhood, persons devoted to scientific pursuits who would willingly lend their aid to redeem from neglect these very interesting objects of antiquity.

THE TRIASSIC OUTLIERS OF DEVONSHIRE.

BY W. PENGELLY, F.R.S., F.G.S., ETC.

Introduction:—That great series of red sandstones, marls, and conglomerates which give so marked a character to the south-east of Devonshire, and collectively belong to what geologists term the Triassic system of rocks, is believed to have occupied formerly a much larger part of Devonshire than that over which it is at present spread. The basis of this belief is a series of isolated patches closely resembling the continuous formation with which they are supposed to have been formerly connected, but from which they have been disjoined by the process of denudation; in other words, by the destruction and removal of those parts of the formation which primarily occupied the interspaces. It is these isolated masses, technically known as *Outliers*, to which I purpose calling attention on this occasion.

With but three interruptions, the red rocks occupy the entire south-eastern coast of Devonshire—from Charton Bay, near Dorsetshire, to the central shore of Torbay. Of the interruptions, the first, or most easterly, is the area of the great Landslip of 1839, extending from the western end of Charton Bay to Culverhole Point; the second is the Beer Head district, where the most westerly chalk cliff of England rests probably on an invisible trough-like red basis; and the third is the peninsula between Babbacombe Bay and Torbay, which, in consequence of a series of great faults, is formed of the older Devonian rocks. Measured in straight lines, the red rocks on the opposite sides of each of the interrupting masses are from a mile to a mile and a half apart; whilst from Babbacombe to Exmouth, and thence to Beer Head, the extent of unbroken red coast is but little short of 25 miles.

It can be scarcely needful to remark, that the portions of the formation which the interrupting masses appear to detach from one another are not outliers. The severance is apparent only. By avoiding the coast route and taking one a few miles

inland, an unbroken continuation of red deposits is traceable from Charton Bay to Torbay.

In collecting the materials for this communication, I have been much assisted by my friend, W. Vicary, Esq., F.G.S., who has accompanied me to every known outlier in the county.

Outliers in the Torbay district:—Omitting outliers, the formation terminates at the northern boundary of Goodrington Sands, Torbay, in a cliff about 75 feet high, and consisting from base to summit of red rocks—sandstone, marl, and conglomerate. The termination is so abrupt as to indicate that it is the result of denudation. In other words, that the formation once extended further southwards. Proceeding in that direction for about a quarter of a mile, a small tidal ledge of rocks is found projecting above the sandy beach; but instead of Trias, it proves to be gritty chocolate slate of Devonian age. About a quarter of a mile further in the same direction, a second ledge presents itself, and is found to consist of similar slate, here and there overlain unconformably by patches of Trias. This, the first outlier southward of the general formation, confirms the suggestion made by the abrupt cliff half a mile to the northward. The red rocks did formerly extend further south than they do at present. This, too, is the first of the very few spots at which the superposition of the Devonian and Triassic systems can be seen. The base of the latter formation is here exposed, and proves to be a very coarse breccia, made up of fragments of limestone and chocolate-coloured gritty slate—materials which, from their composition and angular character, may be safely concluded to be of immediate derivation. The ledge extends in the direction of the coast-line for about 70 yards, and transversely about 140 yards. It terminates landward in a narrow strip of cliff 16 feet high, and composed of similar rock.

At the southern horn of Goodrington Sands, something more than a furlong south-easterly from the mass just mentioned, a second and larger outlier presents itself; the intermediate space being occupied with Devonian schist and grit. This mass is mainly a coarse conglomerate, and is seen to greatest advantage on the southern side of the point, where, jutting seaward at right angles to the general coast-line, it forms a section about 200 feet long, occupies a rude platform in the Devonian chocolate-coloured gritty slate, and abuts against a low Devonian cliff in which the platform terminates. Here the Trias is about 16 feet thick, and the coarse materials

forming its base so fit into the inequalities in the surface of the slaty shelf on which it reposes as to give the two formations the appearance of being dovetailed together. Their unconformability is well displayed also: the conglomerate beds being inclined at an angle of 15° towards N. 32° E.;* whilst the slates dip 35° in the direction N. 67° E.

The entire coast is composed of Devonian rocks of various kinds, from this point to that which forms the northern boundary of the Broad Sands inlet—a distance of something more than half a mile. Here a still larger outlier commences, in the form of the outer portion of a tidal platform of huge blocks of coarse red conglomerate, lying, in all probability *in situ*, on unbroken beds of the same character. This mass abuts against, but does not overlie, the Devonian beds which form the innermost or landward portion of the strand. The line of junction of the two formations runs diagonally, in a S.S.W. direction, across the platform into the cliff, where a large vertical dike of carbonate of lime, composed of crystals of great size, intervenes between the older and the newer rocks. Towards the southern end of the outlier very fine red sandstone is more prevalent than conglomerate, and in it there is a considerable quantity of iron, in the concretionary form commonly termed "pan," which, from its superior hardness, projects in grotesque figures from the general surface of the cliff. The dip of the Trias is not constant either in amount or direction; but one good measurement, showing the prevalent inclination, gave 48° towards N. 59° E. Veins of carbonate of lime everywhere traverse the red rocks in various directions. A thick dike of the same substance separates the older and the newer formations at the southern as well as at the northern end, and probably along the entire length of the outlier. At one spot in this wall-like mass a large cavity, known as the *Crystal Grotto*, has yielded calcite crystals of great size and beauty. This outlier is upwards of a quarter of a mile in length, but can scarcely be said to do more than line the cliff; for though the Torbay and Dartmouth railroad almost overhangs this strand, it passes through Devonian limestone, without any indication of the Trias.

Warren Point, the southern boundary of Broad Sands, about a quarter of a mile from the mass just described, is a low mass of Devonian limestone, having, on its south-eastern side, a hollow in which lie three or four masses or fragmentary beds of coarse Triassic conglomerate. Of these, the upper-

* The directions are corrected throughout for magnetic variation.

most, and apparently the largest, is 13 feet long, 10 broad, and 3 thick; so that this entire outlier cannot exceed 100 tons in weight.

This is the last or most remote of the Torbay outliers, unless we choose to dignify with that name the numerous masses of compact sandstone, each commonly not more than a cubic yard, which are found here and there on the limestone plateau, extending for about three miles from Galmpton Warborough to Berry Head.

There are other evidences, however, of the former existence of the red rocks on the southern shore of Torbay; for, from the railway cutting adjacent to Broad Sands along the entire coast to Berry Head, Triassic dikes, almost exclusively sandstone, occupy many of both the north-and-south and east-and-west joints which traverse the limestone. They can be well seen at Churston Quarry, Fishcombe Cove, Bench near Brixham, the quarry near the Brixham Breakwater, the beach beneath Berry Head House, and at the Head itself.*

True outliers, but on a very small scale, occur on the southern side of the Berry Head peninsula. The first occupies a gap, probably about 50 feet deep and 20 feet in greatest breadth, at the top of an inaccessible limestone cliff, in a narrow gorge between Berry and Durl heads, and about 250 yards north of the latter. The second, and last, is about a quarter of a mile further south, at a spot locally known as Clennage. It is perhaps something, though scarcely larger than that just described, and consists of very compact sandstone similar to that forming the dikes just mentioned. So far as can be judged, the mass north of Durl Head is of the same character.

The outliers in the Torbay district, of which this is the most southerly, are spread over a tract of country about three-and-a-half miles in length. They are neither indicated in the Map of the Geological Survey, nor mentioned in the "Report on the Geology of Cornwall, Devon, and West Somerset," by Sir Henry De la Beche. Indeed, it does not appear that hitherto their existence has been mentioned by any one. Regarded with reference to their volume only, they are certainly of little moment; but as indications, or rather proofs, that, as its abrupt termination in Torbay suggested, the New Red System formerly occupied a larger area, their importance can scarcely be overestimated.

* See Transactions of the Devonshire Association for 1863, page 40; also, the Geol. Magazine, vol. iii., page 19.

Outlier in Start Bay:—Sir H. De la Beche mentions the only two remaining outliers which, so far as is known, exist on the southern coast of Devonshire. Of these, the first is at Slapton, in Start Bay, ten miles south of the mass near Durl Head. This mass is much more voluminous than either of those described above, and may be well seen in the cliff on the western or landward margin of Slapton Lea, as well as at various places in and adjacent to the village, about three-quarters of a mile inland. On crossing the bridge which, at the Sands Hotel, is thrown over the Lea, the cliff both on the north and the south is found to be a raised beach, probably a mile long, but extending further on the northern than on the southern side. On the south it is at once succeeded by Devonian slates, but on the north by well-developed Triassic sandstone and conglomerate, which in their turn give place to the Devonian formation. Both conglomerate and sandstone occur in the village sections also. The latter is very fine grained, and when disintegrated is occasionally used for castings, for which it is well adapted. More frequently than otherwise it forms the uppermost beds of the sections. The materials of the conglomerate are not very firmly cemented. The staple consists of rather small angular fragments of quartz, derived probably from the numerous veinstones of the Devonian slates of the immediate district, with occasional contributions possibly from the metamorphic schists so largely developed a few miles to the south. Well-rounded pebbles of trap, such as occur in the conglomerates from Torbay eastward to the Exe, but the source of which remains undiscovered, are by no means rare. Fragments of very pure limestone occur occasionally. Some difficulty is experienced in attempting to account for their presence; for the nearest known limestone beds are those at Ditsham, on the right bank of the Dart, about six-and-a-half miles to the northward. The difficulty, moreover, is increased by the fact that the fragments are but little rounded. The inclination of the beds is not constant either in amount or in direction. One very careful measurement gave 11° towards S. 77° W.; whilst another, equally trustworthy, in a different locality, was 3° towards S. 8° E. Good examples of diagonal stratification are occasionally seen.

Outliers in Bigbury Bay:—The remaining South Devon outlier occurs at Thurlestone Sands, in Bigbury Bay, eight miles S. 80° W. from Slapton. It really consists of two separate masses; one in the cliff on the mainland, the other the picturesque object known as Thurlestone Rock. The

former consists of well-defined beds, averaging about three feet in thickness, and passing gradually from coarse conglomerate at the base to tolerably fine sandstone in the uppermost strata. The conglomerate is composed of fragments of the Devonian rocks of the immediate neighbourhood, with a large admixture of the crystalline schists, which form the southern angle of the county, and terminate at the Bolt Tail, about a mile-and-a-half in the direction S. 70° E. The fragments are commonly sub-angular, and lie with their longest axes parallel to the plane of stratification. This mass, which now forms a mere strip of coast, is about 150 yards long, and, where highest, rises to about 50 feet above the existing strand. From the foot of the cliff, a beach of gravel and sand extends towards the sea for about 40 yards; and between this and the low-water line there is a broad Triassic platform, which, no doubt, continuously underlies the gravel also. The red beds abut against those of the Devonian system, which are here reddish slates of satiny aspect. The line of junction is well exposed, and is inclined to the horizon at an angle of about 45° in a southerly direction, the modern overlying the ancient rocks to that extent. The two formations are decidedly unconformable, the slates dipping 50° towards N. 5° W.; and the Trias 13° in the direction S. 15° W.

Thurlestone Rock stands unconformably on a tidal platform of Devonian slate, something more than a quarter of a mile in the direction of the dip of the Trias. It is a mass of conglomerate, differing from that on the mainland only in having its materials very firmly cemented together; hence, in all probability, its continued existence notwithstanding its exposure to the unbroken action of the Atlantic waves. Huge blocks of similar rock lie scattered around it on the platform, testifying to the destruction which the breakers have effected, and predicting the fate which must ultimately overtake this small remnant of the Trias of Bigbury Bay. Indeed, the sea has made a considerable breach through the rock itself, thereby at once adding to its picturesqueness, and diminishing its stability.

Outlier at Hatherleigh:—Thurlestone is about seventeen miles south-westerly from Goodrington cliff, and, in this direction, is the most advanced position held by the Trias. The outlying mass which next claims attention is that at Hatherleigh, 40 miles almost due north, but which is no more than two miles north-westerly from the termination of the long strip of Triassic Rocks extending westward, for upwards of 20 miles, to Jacobstow. This outlier occupies a con-

siderable area. In some respects only it resembles the formation to which it is assigned. Thus, it is the correct red, and is composed of more or less angular materials derived from the older rocks of the district; but it is very earthy, destitute of distinct stratification, and the stones it contains lie at all angles, without any approach to symmetrical arrangement. Of the road sections in the several approaches to the village, there is not one in which the ordinary Triassic features can be said to be fully and unmistakably marked; and until the observer has seen the natural section on the right bank of the river Lew—a small feeder of the Torridge—he may well be sceptical respecting the age of the accumulation. It cannot be denied, that its characteristics are such as to suggest that it has been formed of materials derived from the waste of the Trias, mixed with a considerable amount of earthy matter, rather than that it is a true fragment of the New Red system of Devonshire. The section on the Lew is small, but conclusive. Unlike those seen elsewhere in the district, it discloses well marked sandstone, of somewhat coarse grain, distinctly stratified, and dipping at a considerable angle towards the river. Yellowish-drab specks, and circular spots—in all probability sections of spheres—are numerous, and give to the mass a resemblance to the mottled marls so abundant in the Triassic cliffs from Exmouth eastward. Many of the spots in the latter, however, are larger, and their colour is somewhat different.

Outliers in Bideford Bay:—Two unconnected, but by no means widely separated patches of Trias, occur on the southern shore of Bideford Bay, in North Devon, about sixteen miles north-westerly from Hatherleigh, the nearest New Red locality. Approaching the district from the east, the Trias, so far as is seen in the fine cliff section, begins at the axis of the valley ending at Portledge Mouth, about six miles south-westerly from Appledore; and for some distance the entire cliff is formed of its well defined beds, which dip, within a degree or two, towards due north, at an angle of from 25 to 27 degrees. On approaching Peppercombe kilns, about half a mile south-west of Portledge Mouth, carboniferous grits come in at the base of the section, and unconformably underlie the Trias: the latter filling in inequalities in the surface of the former. Soon after they appear, the grits are contorted violently; but, beyond the fold, they dip persistently towards S. 50° E. at an angle of 26°, and take possession of the entire cliff. The Trias, however, soon reappears, and exclusively forms the cliff to Peppercombe

valley, where it ends. The carboniferous grits and shales of the district are of a deep red, so that, guided by colour alone, a casual observer would probably assign to the Trias a much larger area. The Portledge mass is of considerably greater volume than that at Peppercombe; but the latter has obviously been greatly wasted by encroachments of the sea, for the broad foreshore in front of it is formed of Triassic beds, having a very persistent strike, and extending to and beyond the low-water line. The junction of this, the western mass, with the carboniferous beds is concealed in the cliff, but well disclosed in the ground plan on the strand, where the modern is seen to abut against the ancient formation, and not, as in the case of the Portledge mass, to overlie it. Hence it may be concluded that the western outlier was brought in by a considerable fault, which let down the country towards the west. Very considerable portions of both masses are conglomerates, or more correctly breccias, composed of angular materials, derived from the adjacent carboniferous beds, and very firmly cemented together. Yellowish-drab circles of various sizes, similar to those already mentioned as occurring at Hatherleigh, and irregular patches of the same colour, are very numerous in the eastern mass.

Outliers between Tiverton and Holcomb Rogus:—So far as I am aware, the only remaining isolated masses, supposed to be Triassic, are two small patches between Tiverton and Holcomb Rogus; from five to six miles north-easterly from the former, and about two miles to the west of the latter. Unlike those already described, they are comparatively near the continuous formation of which, perhaps, they are fragments.

The first, or more northerly, occupies the somewhat elevated land of Chimleigh Down, in the parish of Hockworthy, and scarcely half a mile westward of the village of that name. It is entirely surrounded with carboniferous grit, which divides it from rocks of the Devonian system on the north, and from the Triassic formation on the east and south: the interspace in the last direction being little more than half a mile. The character of this mass is well displayed in a series of excavations, locally termed "gravel pits," not more than 10 feet deep, which have been made adjacent to the road on the eastern margin of the Down. The finer materials dug here are used as sand in the preparation of mortar, and the coarser for road repairs. A large portion of the mass consists of small, thin, angular bits of rock, in which are incorporated a considerable number of stones, varying in size from that of

hazel nuts to pieces a foot in mean diameter. Most of them are angular, or at most sub-angular, but occasionally a tolerably well-rounded pebble presents itself. The longest axes of perhaps a majority of the fragments have a tendency to a sensibly-horizontal direction, but there is nothing like a division of the mass into beds.

The more southerly of the two masses is also on elevated ground. It is about a mile north of Uploman, and somewhat further, in a southerly direction, from Chimleigh Down. It is best seen in small artificial sections in the narrow lane terminating at Houndsmoor farm-house, and branching off, on the west, from the road running from Sampford Peverell, through Uploman, northwards. With the exception of being of a less decidedly red colour, it differs but little from the accumulation on Chimleigh Down, being composed of materials precisely similar in all respects, and just as destitute of symmetrical arrangement or of division into distinct strata. It is everywhere surrounded, too, with carboniferous grits.

Neither of these masses appears to contain a fragment of either limestone or trap rock, or, indeed, of anything but the carboniferous grit of the immediately adjacent country. This is the more remarkable, as limestones, of carboniferous age, are somewhat largely developed both on the north-east and south-east of each of the two districts; approaching in each direction to within a quarter of a mile of Chimleigh Down, and respectively a mile and a half and two miles of Houndsmoor.

By way of giving greater prominence to the fact just mentioned, it may be stated that the conglomerate, undoubtedly Triassic, of Sampford Peverell, two miles south of Houndsmoor, is almost exclusively composed of fragments of limestone, embedded in a paste formed of the finer *débris* of the same rock. It is obvious that all the materials have been derived from the limestone beds of Westleigh, the western termination of which is about two miles distant, in a north-easterly direction; or about as far as it is from Houndsmoor. The observer at once recognizes the pure limestone, the cherty bands, and the breccia formed of small angular pieces of limestone, firmly cemented with carbonate of lime into a tolerably compact rock, and locally known as "fancy stones" —all characteristic of the Westleigh beds. As long ago as 1839, Sir H. De la Beche stated that this conglomerate was "worked for lime,* and it still remains to be a truth. At present there are in the parish ten limekilns kept constantly

* Report, page 199.

in use throughout the year, and all supplied with material from the conglomerate exclusively. As in the parent beds at Westleigh, it is necessary to reject the chert, but beyond this no selection is made or required. The limestone pebbles, and the calcareous paste uniting them, are alike broken up, thrown into the kiln, and converted into excellent lime, at a cost enabling the proprietors to compete with those at Westleigh, who use the limestone quarried from the parent beds.

Were it not foreign to the purpose of this paper, it would be interesting to speculate on the absence of grit amongst the materials conglomerated at Sampford Peverell, and of limestone amongst those in the outliers. It is not improbable that, assuming the latter to be of Triassic age, these facts may be capable of yielding information respecting the direction of transportation during the era which the deposits represent.

Conclusion:—In taking a general review of the statements contained in this communication, the following facts are found to stand out prominently:—

1st. That the materials composing the conglomerated portions of the Triassic outliers of Devonshire were mainly derived from the older rocks of their immediate vicinities. This conclusion is attested by the untravelled angularity of the fragments, as well as by their exact lithological similarity to the parent beds. Those who have studied the general geology of Devonshire, will recognize this as a generalization of very much broader application; it being as true of the continuous formation, as of its isolated portions to which attention has here been especially directed.

2nd. That, assuming the county to have been covered with Trias to the extent indicated by the outliers, or, in other words, as far west as the line joining Thurlestone and Peppercombe, the New Red formation must formerly have occupied an area 1,200 square miles larger than that over which it is at present spread, without reckoning the great losses certainly sustained in consequence of encroachments of the sea: or, to put the same fact in another form, voluminous as are the existing red rocks of eastern Devonshire, the formation has, within our borders, been stripped off an area as large as half of the entire county, leaving, here and there, no more than a speck, at once to attest its former wider amplitude, and the great waste it has experienced.

3rd. and lastly. That the existing stratified rocks of the world fall very far short of being a measure of the amount of denudation performed, or of the lapse of time requisite

for its accomplishment. Thus, the Trias of Devonshire is a result of the destruction of a mass of pre-existent rock of equal volume, and almost entirely of the stratified class, and, therefore, itself a product of a still earlier equivalent denudation. But the Devonshire Trias is but a small fragment of what it once was. That, seen in its original proportions, it would have told a far nobler tale of the denudation which quarried the materials of which it was built up, let the vast interspaces separating the outliers from one another, and from the general formation, testify. Again, these interspaces tell, not only this story of that early denudation, which supplied the matter for the rocks they once bore, but of that subsequent destruction, which stripped them bare and left them what they now are.

ON THE POOR LAWS;

WITH THE RESULTS OF UNION RATING IN DEVON.

BY E. VIVIAN, J.P., TORQUAY.

THE brightest page in English legislation is that in which it is declared to be illegal for man, woman, or child to starve. Organized relief for destitution dates back to the apostolic age. The first relieving officers were the deacons of the Primitive Church. When ecclesiastical endowments had become consolidated, a portion of the revenues, generally one-fourth, was set apart for the poor. On the dissolution of the monasteries, pauperism, which the lax administration of the ecclesiastical orders had greatly tended to promote, was made chargeable upon the hundreds and corporate towns. By 17 Henry VIII., c. 25, funds for this purpose were to be raised by voluntary contributions; but in subsequent statutes we have a graphic picture of the gradations of moral suasion. By 5 and 6 Edward VI., c. 2 et seq., if any should be obstinate and refuse to give, the minister was gently to exhort him; if he still refused, the bishop was to send for him, and endeavour to persuade him, by charitable ways and means, for his soul's health, and at his discretion to take order for his reformation. By Elizabeth V., c. 23, if he stood out against episcopal exhortation, the bishop was to certify the same to the Justices in sessions, and the Justices were gently to move and persuade him; and, finally, to assess him what they thought reasonable, and in case of refusal to commit him to the common gaol until paid!

By the 43rd of Elizabeth, all preceding statutes were repealed, and a general assessment of property was made for the *relief* of the sick, aged, and impotent, and the *employment* of the able-bodied. With various modifications, and accumulating abuses, this was in force until the Poor Law Amendment Act of 1832. The principal abuse against which this was directed was the payment of wages out of the rates. So far as the amendment was designed to prevent the employer of

labour, then principally agricultural, from unfairly burdening those who did not employ their quota, the new law was unquestionably just; but as it also had the effect of curtailing the charge imposed upon land and real property for the benefit of the poor, it was a violation of statutory rights, and the confiscation of a claim which took precedence of the landlord's rent, and the incumbent's tithes; but by the just and beneficial legislation which at the same time repealed the Corn Laws, and, by removing protection, opened new fields for industry, all injustice was removed, and both the owners of property and the poor were made to share in a general readjustment, which has proved eminently beneficial to all.

The Law of Settlement and Removal was also greatly modified by subsequent acts, and an approximation to a *Union rating* effected by the *Common Fund*, to which the poor were chargeable when they had become irremovable by residence for five years. This term was subsequently reduced to three years, and the Common Fund charge was apportioned to the rateable value of property in a parish, instead of the sum actually expended in rates. By this arrangement much of the last traces of serfdom (*adscriptus glebæ*) was removed, the free circulation of labour was promoted, and the great principle recognized, that those who had benefitted by a man's labour, not those amongst whom he was born or where he slept, should maintain him in sickness and old age.

Still this was but partially effected, until by an Act which came into operation during the present year, *Union Rating* was substituted for Parochial, and the entire charge of pauperism was thrown upon the Common Fund. Sufficient time has not yet elapsed to enable me to lay before the Association the results from any extended averages, but a few facts, from my own observation in the Newton Abbott Union, in this county, of which I have been either an elected or *ex-officio* guardian continuously, since the introduction of the New Poor Law in 1834, will illustrate its probable effects:—

The population of the 39 parishes contained in the Newton Abbott Union was, in 1851, 52,306; and in 1861, 59,063.

The total amount raised by poor rates was, in 1860, £18,366; and in 1865, £23,004.

The total amount expended for relief of the poor was, in 1860, £13,575; and in 1865, £15,515.

The highest rated parish was Ashburton, at 3s. 4d. in the pound; the lowest, Haccombe, 3d. in the pound. The former is an ancient borough, with a decaying woollen manufacture;

the latter an agricultural parish, in the possession of a single proprietor, in a very rising neighbourhood, between Newton and Torquay.

The action of the Common Fund had alone raised the rates in Haccombe more than 400 per cent., and in Cockington and Ogwell, similar close parishes, to nearly the same extent. When Union rating is fully introduced, it is estimated that the rates in the entire Union will be on a uniform scale of about 1s. 4d. or 1s. 6d. in the pound.

In the St. Thomas Union, which may be taken as a fair specimen of the urban population of this county, similar advantages have resulted from the change. Dutton, which never had any pauperism, has by the action of the Common Fund been required to contribute its fair quota to the irremovable poor in other parishes of the Union, and will now be charged in full proportion to its rateable value. Topsham will be reduced from £427 per annum to £300, and other heavily burdened parishes in similar proportion; whilst Heavitree will be raised from £424 to £568, and St. Leonard's from £120 to £264, or more than 100 per cent.

In the close parishes, the worst effects had been produced upon the condition of the labouring poor. Notwithstanding that the proprietors were resident, and very liberally disposed, and have greatly modified its effects, the traditionary policy had always been to discourage the erection of cottages, and the few that remain are valuable only for the picturesque, their mud walls and mouldering thatched roofs forming a favourite study for the artist and the antiquary. The bulk of the labourers reside far from their work, in the neighbouring towns to which, until the introduction of the recent Act, they were almost exclusively chargeable.

The only evil consequence which was apprehended from the change was, that the Unions being so extensive, and the proportional charge of each individual pauper upon the joint fund so small, the guardians would relax in their vigilance. I am authorized by the inspector of this district to state that this has not been the result, but that, on the contrary, the attention of the whole board is aroused by all the charges falling upon their constituents; whereas, under the former system, any guardian who felt a special interest in a pauper chargeable only to his own parish, could always obtain extra relief without exciting opposition from others. It may fairly be questioned whether this would be the case under a *national* rating; but there are many purposes for which a wider area might be advantageously adopted.

Amongst these are the workhouse infirmaries, to which so much attention has recently been directed, especially in the metropolis; the extension of pauper lunatic asylums, so as to admit idiots; reformatories and refuges for neglected children.

Whether it would be desirable to open workhouses as an asylum for children, towards whose maintenance a payment might be required from their parents, is also worthy of consideration. There is one class for whom some such provision is imperatively required, from the lamentable prevalence of infanticide. I refer to illegitimate children. At the last meeting of the British Association, I read a paper advocating that course, which was very favourably received, and was strongly supported in leading articles by the *Daily News*, the *Morning Post*, the *Telegraph*, and other influential journals.

The importance of *preventing* pauperism is so great, that I may, in conclusion, advert to the beneficial influence of Friendly Societies and Savings Banks, now rendered so easily accessible through the medium of the post offices. For those who are dependant upon weekly wages, the Friendly Society is as far superior to a Savings Bank as an insurance against fire is preferable to accumulating the premiums in the Three per Cents. An admirable review of their comparative advantages will be found in the *Encyclopedia Brittannica*, under the head of *Benefit Clubs*, which is mainly founded upon a work by my father, one of the earliest and most successful promoters of these institutions. During the twenty-five years that he was the incumbent of a parish in Hertfordshire, he reduced the rates from 6s. to 2s. in the pound, mainly through the establishment of a friendly society, to the members of which he had the gratification of paying £800 a year, from their own funds, to the sick and aged of both sexes. In his evidence before Committees of both Houses of Parliament will also be found suggestions of all the beneficial changes that were introduced by the Poor Law Amendment Act. "Giving to the poor," said Aristotle, "is pouring water into a sieve; he is their best friend who can aid them to support themselves."

In the higher civilization of the future, we may, I hope, anticipate results such as those which are already realized in the United Kingdom Temperance and General Provident Association, in which one department is confined to total abstainers from strong drink, and the other is open to the general public. The teetotallers, as by a law of nature,

invariably receive a bonus one-third greater than the moderate drinkers, showing a corresponding mortality of two to three deaths. As we have now more than 26,800 members, and have been in operation 25 years, the data are afforded for a thoroughly trustworthy average. In the Rechabite sick clubs it appears, from a parliamentary return by the Health of Towns' Commission, that the sickness experienced is not more than one-third of the general averages.

The history of the English Poor Law may be elucidated, in all its stages, by the systems now in operation on the continent of Europe.

The *Villainage* of the feudal age was, until quite recently, represented by the *serfdom* of Russia.

The *Monastic* system is still in full force in Spain, Austria, and the Netherlands.

The official distribution of alms, more or less voluntary, of the transition period, is fully represented in Prussia, Belgium, and France, with its *Bureaux de Bienfaissance*. And in Italy by the *Monti de Pieta*.

In Norway, employment is provided for the poor by a compulsory system of *rounds-men*, shifting them from farm to farm, with, as in Sweden, grants from the general revenue —in fact, paying wages out of the rates.

The means taken to prevent abuse in many of these states, also, closely resemble the old English laws. In Russia the nobles were bound by law to support the serfs, but they possessed power almost of life and death, as under our feudal system, when a sturdy beggar, who would not work, had his right ear cropped, and for the second offence was convicted as a felon. The same pressure, chiefly ecclesiastical, is brought to bear upon refractory voluntaryism, and Malthusian restrictions upon undue increase of population are rigidly enforced; amongst these, in Bavaria, any priest who marries a couple who are unable to provide for their children is made liable for their maintenance.

The English Poor Law is founded upon the true spirit of Christian charity, which "seeketh not its own," but denies itself the gratification of personal alms-giving, in order to secure the welfare of its recipients. Notwithstanding the protest of O'Connell and Chalmers against the introduction of a Poor Law into Ireland and Scotland, and the objections of foreigners, experience has shown, that private charity inevitably serves to promote demoralization and pauperism. The objections, on the other hand, are thus expressed by a Danish nobleman (Count Holstein) to the Home Secretary, in reply

to an enquiry relative to the Poor Laws in Denmark. "The rich man, and the poor man," he says, "both suffer; the former, in that there is no place left for the exercise of his benevolence, being obliged to give, as the poor man, on his part, is obliged to work. He performs the obligation with reluctance, and thus is the highest principle of charitable action—Christian love—exposed to danger of destruction."

True Christian charity is, I believe, most legitimately exercised by securing the supply of actual necessaries to all, with the apostolical proviso, "He that will not work, neither shall he eat;" and rare, indeed, must be the circumstances in which an ample field cannot be found for the exercise of personal beneficence towards providing special comforts to those for whom no Poor Law can afford adequate relief.

The position of Poor Law Guardian affords an opening to the truly benevolent of benefitting the poor upon the widest scale; whilst the general superintendence of the Poor Law Board secures uniformity of action, and prevents abuses which would be injurious alike to both giver and receiver.

PHOTOGRAPHIC PORTRAITURE.

BY DR. SCOTT.

ONE of the features of this Association not common in Institutions of a similar character is, that it includes within the circle of its operations subjects connected with art, as well as those peculiarly scientific. Modern study has too often sought to divide those daughters of civilization by a too sharp line of demarcation, forgetting how frequently they come closely in contact, and how often they might assist in advancing each other. We can scarcely glance at a single branch of the Fine Arts which would not afford examples of this truth. Yet the artist, at least, too often neglects to avail himself of the scientific knowledge that might assist him in better contending with the difficulties of his art. One of our great National Museums—and that the most recently established—is, however, a happy example of the contrary of this unnatural divorcement; I mean the South Kensington Museum. Here we find illustrations showing how this combined study can be made valuable to him who desires to become wise in either *specialitié*, and has drawn attention to a principle that the modern feeling for "division of labour" had almost extinguished.

The subject which I venture to bring before you to-day is one where some knowledge of both science and art is peculiarly requisite, if we would practise it successfully; but where, from the absence of such a knowledge, we so frequently find the most melancholy examples of failure.

Sun-painting, as you are aware, is an art resulting in the application of some of the most delicate and interesting truths of chemical science; and it is to a branch of this art, viz., "Photographic Portraiture," that I am desirous of drawing your attention.

Now that every one has his or her portrait taken by this means, it becomes desirable that there should be a wide spread knowledge of the subject; and more especially, since amongst the portraits generally seen we find such evident

ignorance of the scientific truths necessary to produce good and pleasing results. Photographic art requires a knowledge of several sciences, if a man would practise it more than empirically. He should be a chemist and an optician; and to produce pleasing pictures he should also be an artist. But it unfortunately happens that a man may now follow—and often does so—the art without any pretence to these qualifications. For the materials and other means for practically producing pictures have been so reduced to rule, that any man whose fingers are not all thumbs may practise it. Hence it is that it has lost much of its original charm for amateurs. Photographers, who followed the art for the interest they took in its relations to chemistry, or in determining the nature of the lenses best suited to produce satisfactory pictures, or from the hopes they had of its becoming an important hand-maid to art, have generally fallen off, while it has been chiefly left to persons who follow the calling only as a source of profit, and who seldom have more interest in it than for the gains that it brings; and hence we have so few practical photographers really art students. Indeed, it appears a kind of refuge for the destitute, as the schoolmaster was of old: when a man cannot succeed in anything else, he can always have a trial at this. Of course, there are exceptions to this: it is not always the case, but as a general rule, photographic portraiture displays a most unfortunate lack of artistic knowledge; and one can only suppose such to arise from a want of artistic feeling, or an ignorance of the capabilities of photographic science.

We cannot look at the great mass of photographic portraits without being painfully impressed with the want of artistic treatment they display, in their bad arrangement of lines, their want of subordination of parts, their distortion of the more prominent features, and a total want of consideration as to what will be produced by different coloured dresses on the photographic image.

In considering the subject, then, to-day, I shall arrange my observations under the following heads. 1st, The defects arising from a want of due appreciation as to how different colours affect the photographic film. 2nd, The optical errors producing distortion of features, and 3rd, The artistic defects arising from a bad arrangement of lines, insufficient subordination of parts, and bad *chiaro-oscuro*.

First, then, as to the effects of different colours producing dark or light tints on the photographic image. Persons when they go to have their portraits taken—especially ladies—

generally dress in such costume as appears becoming and ornamental in colour as well as form; and from the correct taste so general amongst the fair sex, could the photographer give us colour instead of mere gradations of light and dark, no doubt there would never be much to complain of. But this is not the case. Photography has as yet only given us the various tints of shade from black to white, and it is in the want of knowledge or want of attention as to how the various colours will "come out" in depths of shade in relation to each other, that so many unfortunately treated portraits meet our eye.

In photography, the sunbeam is our pencil, and a surface covered with a certain chemical preparation our drawing board; and it is in knowing how the one acts upon the other that our part of the art lies. Every beam of light consists of a bundle of rays, each ray having a distinct colour and a different effect upon the ground prepared for our picture. If we allow a pencil of sunlight to fall upon one angle of a prism, we separate these rays, and we have an elongated image presenting us with various brilliant colours, as seen in this diagram.* This image is termed the solar or prismatic spectrum. The solar spectrum is usually considered to consist of seven primitive colours—viz., red, orange, yellow, green, blue, indigo, and violet. Sir David Brewster, however, was led to believe, from observations that he made, that these colours were indeed only *three*—viz., red, yellow, and blue, the others being produced by the overlapping of the contiguous ones; as, for example, orange being produced by the overlapping of the red and yellow, and green being compounded of blue and yellow mixed by the same means. In the spectrum we find the different colours always arranged in one succession—viz., the same as that shown in the diagram, the red being at one end, and the violet at the other; illustrating the fact, that these colours have different degrees of refrangibility, the red being the least refracted, and the violet the most.

Though the rays here represented are the only ones visible to the naked eye, there are other rays at each end of the spectrum which can be detected if proper means are used. If, for instance, we look through a deep blue glass, we shall find, beyond the visible red ray, a ray of a deeper red still, which has been designated the deep red, or crimson ray. Again, if we allow the spectrum to fall upon a sheet of

* The paper was illustrated by diagrams, to which the author at different times referred.

yellow paper, a ray will appear beyond the visible ray at the other extremity, which Sir John Herschel has named the lavender ray; while still beyond this again Mr. Stokes has shown, that by throwing the spectrum upon a solution of quinine we can get a prismatic image.

The interest connected with the prismatic spectrum would tempt us to dwell upon it for a longer time; but as already enough has been said for our present purpose, to do so would only lead us away from the subject more immediately under our notice.

We have seen, then, that the sunbeam consists of a series of rays, which are shown in the spectrum under the different colours: and these rays are found not only to have different colours, but also to be endowed with different powers.

Light and heat were long considered as the only qualities of sunlight; but more recent experiments have added another property, which has been designated *actinism*, from the Greek word ἀκτις, a ray or flash. This term therefore designates the property of sunlight which produces chemical change, and it is this power which enables us to take photographs. The illuminating rays do not do so, nor do the heat rays; but in the chemical or actinic rays resides the solar force by which we take photographic pictures.

Of the different rays which have been found connected with the different powers of *light, heat,* and *actinism,* the maximum of actinism lies in the violet ray, while its minimum is in the yellow ray; while, on the contrary, the maximum of illumination resides in the yellow ray, and its minimum in the violet. It is this feeble power which yellow light has on the photographic plate, that enables us to work by the light of a candle, or sunlight transmitted through yellow curtains. If all the rays of light were equally powerful in actinism, of course we should have to work in the dark. Again, the heat rays have their maximum power in the red rays, and their minimum in the violet. Actinic action is not, however, wholly limited to the violet rays, but is more or less found present to a moderate degree in the others, extending even beyond the visible spectrum to that blue ray already alluded to as having been made visible by Professor Stokes, by the means of a solution of quinine.

Having seen, then, that the sun's rays are not all equally operative as photographic agents, you will be better able to see how such remarkable phenomena occur sometimes in taking portraits, as is found when ladies go dressed in various colours. You will bear in mind that colour is not an in-

herent quality of matter; colour in objects being produced from their reflecting certain rays, and absorbing others. Thus blue objects absorb all rays but the blue ones, which they reflect; red objects reflect only the red rays, and absorb the others, while yellow objects in like manner reflect the yellow rays, and absorb the others. Now a lady going to have her portrait taken in a yellow dress would naturally think it would "come out" of a lightish hue, and she would be very much surprised to find that it came out almost black. But such is the case, and from the reasons I have endeavoured to explain in my remarks upon the prismatic spectrum. Hence, if a lady wishes to appear in any particular tone of dress, it is of great importance that the colours be properly selected chemically, and not such as will produce darks for light, or the contrary. It is also important to remark, that the *surface* of the material has a considerable influence in the photographic effect. A substance having a good reflecting surface considerably helps its action upon the silver film. Silks and satins are more favourable for producing effects than velvets or coarse stuffs, which, from their rough non-reflecting surfaces, affect but feebly the sensitive plate.

Again, a very common dress amongst gentlemen is a black coat and grey trousers: but this is a much too violent contrast to be pleasing in a photograph, especially if the blue preponderates in the grey of the trousers. We have hard sharp lines of demarcation between the two garments wherever they touch, and hence we get a picture full of lines, not only disturbing the quietude of the whole, but often running in very disagreeable contrast. Again, it is difficult to get a dark dress and the flesh tints both properly done together, the radiations from the light complexion of the skin being much more effective on the plate than those of the dark dress. It takes tact and experience, therefore, to give that proper medium of time which will do best for both, without materially injuring either. But as the face is, or ought to be, in all cases the most important part of the portrait to have satisfactorily done, every thing else should give way to this end.

It is, then, of the utmost consequence, in dressing for a photographic portrait, to consider well the colours—not as regards their harmony as a well balanced combination of colour, but as to what will be their effect on the prepared plate. It is very common to see ladies going in dark dresses with long floating ribbons of white or blue, large white cuffs and collars, &c., &c. Such costume produces pictures of such violent opposition, and with blotches of white so large,

that the face is almost lost sight of, from being so thrown into the shade by these preponderating masses of white. It is thus that portraits are produced so different to what the sitter expects, and so opposite to what is either desirable or pleasing. This wearing of ornamental caps and capstrings, collars and cuffs, dresses slashed with purple trimmings, white handkerchief in hand, &c., is the ruin of many portraits that otherwise would be passable. All these white parts come out as so many spots in the picture, generally without having any shadow to give folds or texture in the material, and spoiling in every respect the effect of the work. It may be difficult for a photographic artist to interfere with the dress of his sitter, but as sitters generally cannot be expected to know the capabilities of the art, it is certainly due to his patrons, as well as to his own reputation, that he should be particular in insisting on parties wearing such dresses as are best calculated to produce satisfactory results. It is, indeed, in the hope of making these facts more generally known amongst sitters, that I have ventured to bring this paper before the Association; because, without some general notions of the limitations of photography become known generally, the artists themselves will never be able to insure such attentions to dress as are desirable.

The great principle of dress is, that it should be of a quiet hue, and not ornamented with trimmings that will give opposite tones, such as black and purple, nor be in any way disturbed by violent contrasts of tone, breadth and quietude being essential to give pleasing effects, and sufficient importance to the face. Indeed, in pictures so small as "cartes de visite," you cannot afford to have any white spots or patches. If they are introduced, it will be at the expense of the face. The best plan, therefore, is to let the dress be one quiet colour, keeping even the hands in an unobtrusive position, so that the face may stand out at once the chief feature of the picture, so that it may catch and retain the eye, without being interfered with by anything else.

Our next point is the distortion of the features. A very common error in photographic portraits is, that the more prominent features, such as the nose, the lips, the chin, the hands, and the feet, are out of all proportion to the other parts of the body: they are far larger, in fact, than they should be.* This distortion is mainly produced by a desire to

* Since this paper was written, M. Claudet, to whom photography owes so much, has proposed a method of taking portraits to get quit of this evil.

get large pictures, combined with a want of a proper appreciation of the powers of the lens. There is always a wish in sitters to have their portraits as large as possible, and it is when we see portraits taken large that we have the greatest faults as respects the distortion of the image. The truth is, when we focus a face in the camera, we are only mathematically correct for one plane of that face; whereas you know that no face is a plane, though we hear sometimes of "plain faces." If we focus for the eyes, the nose will be in front and the ears behind our true focus, and both, therefore, will be untrue, or suffer from distortion. As we augment the size of our pictures we make these errors more apparent, till we see in some large heads visages that hardly appear human. Formerly there was another difficulty to contend against in getting a good focus—viz., that arising from the want of coincidence between the foci of the visual and chemical rays. When we had obtained the best focus on our ground glass, we had still to calculate where we should place the sensitive plate, since the violet rays, having more refractive power than the yellow ones, throw their focus somewhere in front of them. Now, however, this difficulty is obviated by having lenses so constructed as to produce coincidence between the visual and chemical rays, and much of the character of a good lens is to be attributed to its perfection in this particular.

In taking photographs, the first requisite of a good picture is stillness—perfect stillness. Unless we have this, we get a confused mass of meaningless shadow. But living objects have always great difficulty in remaining perfectly still for any length of time; and, indeed, before people were required to sit for their portraits by this method, they hardly knew what perfect stillness meant. To get this stillness, then, is the first object; but to get it, the sitting must be short, and to get our portrait in a short sitting, we must have a rapid action in our chemicals, and a lens of a short focus. Now a short focussed lens is only another term for a small picture; for the size of the field which a lens will cover satisfactorily is in proportion to its focal length. The proportion which the one bears to the other is about that of six to ten; or in other words, a lens with a focus of ten inches will cover a field of about six inches square: but ten inches is a long focus for portraiture, the focus here seldom being more than four to five inches, which you see will give you not a very large picture. To get rapid action, also, in the larger portraits, we bring the sitter near to the lens, which is another means of increasing the distortion of the image to a considerable extent.

Hunt says, "For portraiture, and all purposes requiring great distinctness of outline and rapidity of operation, two achromatic lenses are usually employed. By this arrangement the focal distance is diminished, and the image much reduced in size; but even then," he adds, "though the distortion is not so much as has been occasionally represented, it may by careful examination be discovered in the finest photographic portraits to a greater or less extent." Let not, then, those who seek to have portraits by this method require them of a large size. The larger they are taken, they will be generally found to be the less satisfactory.

Our next consideration will be to look at photographic portraits as works of art; and here, perhaps, we have the most cause of complaint,—not only because the evils we have hitherto been considering are more or less incident to the process itself, while those we are about to allude to are not so, but also because, in most of the portraits we meet with, where pictorial effect is attempted, we find violations of well-established and universally acknowledged principles of art. It is from there being little or no artistic effect attempted in vignettes, that we find them so frequently the most agreeable pictures; and as it is easier to get a good and satisfactory vignette than to get a good full length portrait in photography, it would perhaps be desirable that this kind of portrait should be preferred. In a surface so small as that of a carte de visite, the mere treatment of the features is not of such great importance. It is in the composition of the picture, or the collocation of the several objects in the work, both as relates to each other and with respect to the whole, that the chief faults of photographs are seen.

These errors are visible not only in the size and distribution of the masses, but also in the want of *chiaro-oscuro*, so important in giving life and vigour to pictures which have mere light and shade to depend upon, and in the entire want of subordination amongst the different parts. In a photographic picture, the chief object to be given, and to which all others ought to be subservient, is the face. Here we ought to concentrate all our interest, and place it, of course, in the most agreeable light and shade. Its being near to or far from the top of the picture will give the sitter height or shortness, and this ought to be always attended to, if we are desirous of giving a good impress of our subject as a whole. Then we should allow no object to be introduced that is likely to interfere with this height—such objects as give lines crossing the figure directly at right angles, as that stock-

piece of photographic furniture, a balcony. I never see this balcony but it reminds me of a story of a sign-painter, who, though his range of subjects was limited, yet excelled in painting one thing—viz., a red lion. Whenever he was sent to paint a sign, whatever the landlord or his better half proposed, the artist was sure to talk them round to a red lion. This was a true sign for a British landlord to have. So it is with the photographs. A portrait itself is something sentimental. It is often a love-gift; and what so suggestive of moonlight nights, soft sighs, sentimental serenades, and stolen kisses, as a balcony. So we have a balcony in all possible forms, and under all possible conditions. Another object which constantly meets our eye is a Greek column, or something that is intended for such. This is introduced into all manner of interiors. For what purposes one cannot possibly imagine, or to what particular order it belongs it is difficult to tell. Then the high backed profusely carved chair is another piece of furniture in great request. And these chairs show their legs to such an extent, and with such ostentatious obtrusiveness, that one gets to feel, with the American ladies, the indelicacy of the exposure. In fact, it often becomes a question whether or not the artist intended to give the portraits of balconies, columns, and chair-legs, the sitter being merely an auxiliary, so prominent are these made, thus violating entirely that subordination of parts to which I have already alluded, as being a necessary feature in good artistic composition. The mistake appears to be, that many persons think it possible to make a picture more pleaing and impressive by filling it with beautiful objects; but this is not the case. The truth is, that such a mode destroys the effect of a picture. Were the materials of twenty pictures crammed into one, it would entirely fail in producing any great impression as a whole, because the value of the separate parts distracts and divides the attention, till at last it can hardly feel affected by any. This is true in all art, and how much so it is in a photograph of the kind we are speaking, will be easily felt, when we only just consider the smallness of our surface and the limitation of our materials. The truth is, that the less extraneous matter put into a portrait of this kind the better—a plain background of good tint, leaving the head to depend upon itself, will be far oftener a successful portrait than when it is to be helped by such auxiliaries as bookcases, pillars, balconies, or high-backed chairs, carved though they be ever so elaborately. There is another point of composition besides the distribution

of the objects introduced, on which depends very much of the effect—pleasing or otherwise—which a picture produces, and that is its light and shade. And here we see very little successful treatment in photographic portraiture. It is from the due amount and proper distribution of light being of so much importance in producing a pleasing picture, that the dress of the sitter, chemically considered, should be so carefully selected, and which I have referred to in the earlier portion of my paper. Because, however carefully a man may arrange his sitter, and however good the composition may be in light and shade when the natural colour of the clothes are viewed, it is quite another thing as to how "they may come out" in the picture. Say we have a black coat and grey trousers on a man. These make not a bad combination in the natural colours,- the lights of the coat go into the shade of the trousers, while the mass of the latter gives us a good mass of middle tint, and hence we have a breadth of effect that produces a pleasing oneness in the whole. But does this come out so under the lens? Certainly not, especially when we are to consider the chemical action required for the face. We get the coat of dead black surface, without texture at all, and the trousers almost white, especially if the grey has an excess of bluish tinge; hence we have a violent contrast, leaving all the lines of each hard and cutting, and the mass of light generally overpowering the face altogether. The mass of dark, as far as I have been able to observe, should be kept towards the bottom of the picture. It should gradually creep down on one side, perhaps at the back of the figure is best—and massing itself towards the lower part of the sitter, place the feet and legs in such shadow as will prevent them appearing so defined as if they were carved in mahogany. This arrangement, however, no doubt may be varied with good effect, and it is the duty of the artist to so study his art as to become acquainted with all the varieties of light and shade that may be advantageously introduced. The background should be of an even tint, and lighter towards the top. A curtain is often seen hanging down one side, and this is not a bad arrangement, if all pattern be destroyed, and no hard outline allowed to form a long line against the background. It may also be made useful in bringing the figure into the background, to prevent the hardness felt when all the outline is distinctly traceable. You never see a picture from the easel of a great master where every part of the figure stands forth in marked outline from the background. The truth is, that by such a plan you cannot get roundness, not

even when colour is used. When a picture is painted in such a manner, it looks like a figure cut out in paper and stuck on to the background; and such an effect is very often visible in photographs, arising from the treatment we complain of. Again, the spottiness produced by white handkerchiefs, collars, cuffs, &c., is an evil of the worst kind, and prevents entirely any fine artistic feeling getting into the picture. We have very little room, indeed, in a carte de visite portrait, to do more than give a pleasing and simple impress of our sitter; and the quieter we keep our picture in every respect the better; and I believe we can only do so by endeavouring as much as possible to avoid the errors I have spoken of. We avoid them entirely in vignettes, and here we never get anything that is painful or disagreeable to the best educated artistic eye, if we avoid making them so large as to give the features distortion. I have now noticed, as far as time and the occasion permit, the chief faults I have to find with photographic portraits; and I have not brought forward these short-comings of photographers in a fault-finding spirit, because I feel that if sitters had some better knowledge themselves of the capabilities and the limits of the art, they would not be so desirous of seeking from photographs what cannot be satisfactorily given, but content themselves with what the art can bestow, both to their own satisfaction and the credit of the operator. One consolation, however, remains, that applies even to the worst representations of a sitter. The deformities will not be perpetuated through all time, nor indeed for any very long period—from ten to twenty years will probably see the end of most of them; for longer experience only convinces me more and more, that what I have stated elsewhere before is true, that photographs, as at present taken, will fade, and that after ten years signs of decay in most of them are only too apparent.

ON A NEWLY-DISCOVERED SUBMERGED FOREST IN BIGBURY BAY, SOUTH DEVON.

BY W. PENGELLY, F.R.S., F.G.S., ETC.

In a paper on "The Submerged Forests of Torbay," read in 1865 before this Association, I remarked, "Descriptions have frequently been given of numerous forests of this kind, which occur along both the northern and southern coasts of Devonshire and Cornwall. It is probable, however, that many exist which have never been recorded, and which, indeed, are but rarely seen;"* and I then mentioned the fact that, by a great and almost sudden removal of sand at Blackpool, near Dartmouth, a submerged forest was disclosed in 1802, and also about 50 years subsequently; but that there was reason to believe that it had never been laid bare during the interval. The object of the present brief communication is to mention and record the fact that very recently a forest has quite unexpectedly been seen in a new locality on our southern coast.

On the 11th of April, 1866, I received, from the Rev. P. A. Ilbert, rector of Thurlestone, a note which led me to believe that an unrecorded forest had been detected at Thurlestone Sands, between the Bolt Tail and the river Avon, in the eastern part of Bigbury bay, on the southern coast of Devonshire. I at once wrote, requesting information on sundry points, and, in reply, learnt that a few days previously Mr. Ilbert's children informed him that close to the northern side of the tidal platform of rocks on which stands the famous Triassic outlier, known as Thurlestone rock, the late storms had so displaced the sands as to disclose portions of trees, which they supposed to be relics of the old wood which, according to tradition, once stood there.

On going to the spot, he found, at about 150 feet seaward beyond the high water mark, where at spring tides there would probably be, in still weather, 13 feet of water, the commencement of a mass of dark blue clay, containing

* Trans. Devon. Association, 1865, p. 32.

vegetable remains, and having, when stepped on, the consistency of "newly made asphalte pavement." It was about 15 feet wide, and extended seaward, or north-westerly, for a distance of 94 feet, where it terminated; but beyond a sandy interspace of from 20 to 30 feet it appeared again, and continued in the same direction for a further distance of 50 feet, with a width scarcely so great as that of the first patch. The thickness of the peaty mass has not been determined.

No distinct indications of roots are discoverable, and the appearance is as if trees of various sizes had been thrown down in the mud. One of the trunks, from 15 to 18 inches in diameter, lies almost horizontally. Another, about 8 inches thick, is inclined to the horizon at an angle of about 30°, and at the upper end is about 2 feet above the general level. In some instances the characters of the wood are well retained, and render it easy to ascertain that oaks formed part of the ancient forest. There is an immense quantity of bark in quite a good state of preservation. Hitherto no animal remains have been found.*

Mr. Ilbert, who has resided at Thurlestone during 25 years, and is much interested in the local geology, had never previously seen or heard of the forest, but he had frequently noticed lumps of the clay cast up with the sand, and had been much puzzled to account for them.

He has been so good as to send me a characteristic series of specimens. The character of the clay, the condition of the wood and bark, and the situation of the peaty accumulation, are so precisely the same as those of the well known forests of various parts of our sea-bord, that, thanks to Mr. Ilbert, Bigbury bay may now, for the first time, be placed in the list of Devonshire submerged forest localities.

Knowing that these remnants of the ancient woods of South Devon occur in Torbay, at Blackpool, at North and South Sands in the Salcombe estuary, and in Bigbury bay, we may not unreasonably believe that, attention being given to the subject, they may be detected beneath the extensive sands which occupy other parts of the coast line. During stormy seasons, these sands are liable to sudden and great displacements. In the present year, sand and shingle to the depth of 7 feet have been stripped off in a single tide, from the entire length of the three miles of beach at Slapton, south of Dartmouth. Were opportunities of this kind carefully

* Since this paper was read, a piece of bone has been found in the blue clay by the Rev. Mr. Rollestone, of South Milton. It has the dark colour characteristic of Submerged forest bones.

watched, we should probably find that, with the exception of its rock-bound portions, our entire coast is engirt with submerged forests.

It has been intimated already that there is a tradition that an old wood once stood at Thurlestone Sands. It seems probable that this tradition rests on no other foundation than the fact that the vegetable remains lately found there had been seen occasionally and at rare intervals by much earlier observers. It is obvious that the forest area was once dry land, and that the sea has gained possession of it, not by simply cutting back the coast, since this must have destroyed and removed the soil as well as the trees it bore. Instead of this, the soil and trees are *in situ*, and the sea *covers* them. They have not perished or migrated, but have sunk, in common with the rest of the sea-bord, to a lower level. Now this subsidence, though probably falling within human times, is not likely to have occurred so recently as to be within the reach of tradition. Our predecessors, in order to account for the vegetable remains which they occasionally saw disclosed in the sands, assigned a forest to the district; and this forest, though correctly located, seen by the mind's eye only, is in all probability the forest of the tradition. Possibly the *traditional* woods mentioned, it is said, by Florence of Worcester, as having once existed in the Mount's Bay, in Cornwall, may rest on a similar foundation—the well known submerged forests of the district.

ON A FLINT-FIND

IN A SUBMERGED FOREST OF BARNSTAPLE BAY, NEAR WESTWARD-HO.

BY HENRY S. ELLIS, F.R.A.S.

I BEG to draw the attention of this meeting of the Association to a collection of broken flints, flint flakes, and flint implements recently found by me in the submerged forest bed on the outside of the Pebble Ridge, in Barnstaple Bay, near Westward-Ho.

In addition to the flints, I have placed on the table some specimens of the various kinds of woods, roots, and other vegetable matter which compose the forest bed, some of the angular fragments of the carbonaceous grit pebbles which underlie the forest bed, and some of the blue mud deposit and other substances from beneath the pebbles, in order that geologists may determine approximately the age when the flints were broken.

The submerged forest bed is situated outside the southern end of the Northam Pebble Ridge. It may be traced in patches from the foot of the pebble ridge to near low water mark, it extends north and south along the shore for about 200 yards, and probably under the ridge into the Northam Marsh. Its height may be estimated at about the mean level of the sea.

That part of the forest bed which contains the flints consists of decomposed vegetable matter, prostrate boughs, or trunks of trees (birch, alder, and the oak), intermingled with roots, nuts, and acorns; and it rests invariably on a stratum of angular fragments of carbonaceous grit pebbles, closely packed together, only a few inches in thickness, which pebbles seem to be in a state of decomposition. These angular fragments would at first sight seem to have been artificially formed, but underneath this bed is a deposit of blue mud, in the upper layers of which are found other pebbles of the same kind, which have been *split* without being much separated, as if by pressure *in*

situ. On these lower pebbles are the markings of fibrous vertical roots, and through the mud deposit I traced, in a vertical direction, one root, or stem, of about an inch in diameter, to the depth of about four feet.

The flints exhibited were found in that part of the forest bed which is about midway between the pebble ridge and low water mark, at a depth below the surface which varied from one to eight inches. In the first bed, nearest to the pebble ridge, I did not find a single flint.

Many of the flakes, it will be observed, are of the well known type described by Sir John Lubbock, in his work on Pre-historic Times, as that of the first stone period, and many others are evidently the cores from which flakes have been knocked off.

I submit that the keenness of the edges of the flakes is evidence of their having been undisturbed since they were formed—my experience being, that flint flakes require extraordinary care to prevent the edges from becoming serrated. I submit also that the cores should be carefully examined, and be compared with the broken flints from the pebble ridge, as the cores seem to bear evidence on them of having been chipped many times successively from the same sides, where the fractures would best assist in forming other angular flakes, and of having been left unwrought, where the natural crust of the flint would make the tool ill-shaped and imperfect. I must own that I have a strong impression that the flint flakes are the result of man's work; but if man's work, I think it does not necessarily follow that it is of very great antiquity. Not long since Mr. Townshend Hall discovered a number of wooden stakes, or piles, standing vertically in the forest bed; and as there is evidence that the pebble ridge is constantly driven inland by the sea, it is not improbable that the submerged forest bed may have been within the ridge, and been a part of the Northam Marsh at no very remote period, and consequently the flint implements of no very great antiquity; but of this geologists are the best judges.

Before concluding, I will just mention that elephants' tusks and deer's antlers are often dredged up by fishermen in the bay; but at present it is impossible to determine whether they belong properly to the submerged forest, or are a portion of the cargo of a wrecked vessel.

ON THE LITHODOMOUS PERFORATIONS, ABOVE THE SEA-LEVEL, IN THE LIMESTONE ROCKS IN SOUTH-EASTERN DEVONSHIRE.

BY W. PENGELLY, F.R.S., F.G.S., ETC.

Introduction:—That the land in the south-east of Devonshire stood at a lower level in what, geologically considered, may be termed very modern times, and that it reached its present elevation by slow and gradual upheaval, with protracted periods of intermittence and even of subsidence, are propositions attested by abundant and varied evidence, such as vertical cliffs, terraces or platforms of denudation, "pockets" and fissures filled with gravel, raised beaches, submerged forests, and lithodomous perforations.

The entire subject is eminently interesting and attractive; but on the present occasion I purpose confining myself to the Lithodomous Perforations which, from Petitor in the north to Sharkham point in the south, are found at various heights above the sea.

They occur only in the approximately vertical surfaces of limestone rocks, there being no known examples in the extensive comparatively soft Triassic cliffs. They may be seen at Petitor, at the entrance of Kent's Cavern, in Asheldon hill immediately north of that in which the cavern is situated, and at Sharkham Point. Until very recently they existed also in a small inland cliff near Mudstone Bay.

At Petitor the perforations are numerous, well-marked, and about 235 feet above mean tide.* They occur in a small cliff projecting upwards from the greensward on the southern slope of the limestone hill which rises, in the midst of the Triassic rocks, between Oddicombe and Petitor beaches, in the parish of St. Mary Church.

The two entrances of Kent's Cavern are about 50 feet

* In this paper the heights have been determined by ascertaining, with pocket aneroid, the difference of level of the various stations and the nearest bench marks of the Ordnance survey.

apart, and occur in a low natural cliff running nearly north and south. The perforations are near the vertex of the northern entrance, and about 200 feet above mean tide.* In the adjacent Asheldon hill they also occur in a small cliff at the 200 feet level.

On the northern slope of Sharkham point perforations are numerous. They occupy a vertical zone extending from 95 to 165 feet above mean tide, and occur in crags of limestone rising almost vertically from the turf which otherwise covers the hill side.

The very fine examples of perforations formerly to be seen in a small cliff, some distance from the coast, between Brixham and Mudstone Bay, and slightly more than 200 feet above the sea, have recently been destroyed by the ordinary operations of the quarryman.

Objections to the Marine Origin of the Perforations:—Of those who have had an opportunity of examining them, a very few only have doubted that the perforations were formed by marine mollusks. The objections which have been made are:

1st. That many of the holes penetrate the rocks horizontally, instead of vertically downward.

2nd. That in a few instances they are more or less curved in direction, whilst they should be straight.

3rd. That they are cylindrical, but should be pyriform.

4th. That no one has ever seen *Pholas dactylus* in limestone.

5th. That they were formed by snails recently, not by marine mollusks during a different relative level of sea and land.

6th. That instead of being of organic origin, they were produced by a rotary motion communicated by water to grains of sand.

I cannot attach much importance to any of these objections: for,

1st. An inspection of the work of the various species of *Pholas* or of *Saxicavæ* shews that, whilst in a majority of cases the axis of perforation is no doubt at right and other high angles to the horizon, it sometimes takes a horizontal direction. As the specimens on the table show, it is possible to detach specimens of rock, with the mollusks in their holes,

* Since this paper was read, a very large number of perforations have been found in Kent's Cavern hill, a few feet above, and somewhat to the south of, those at the entrance.

in which the directions of boring vary from horizontal, through all degrees of inclination, to vertical.

2nd. The recent specimens now exhibited show also that the axis of boring is not invariably a straight line. Instances in which it is curved are by no means rare.

3rd. It will be seen also that in the slabs now produced, the modern holes are either cylindrical or slightly conical: not one of them having any tendency to be pear-shaped.

4th. It may perhaps be true that no one has seen *Pholas dactylus* in ordinary limestone; but, so far as I am aware, no one insists that the fossil borings were produced by that mollusk.

5th. If snails formed the holes in question, they have very provokingly selected for their operations none but the very spots in which, guided by other and independent marks of marine action, the geologist would predict the probable occurrence of perforations wrought by marine mollusks; and they have carefully avoided the artificially exposed cliffs in our numerous old disused quarries.

6th. The suggestion that, on the surface of a vertical cliff, water could give to grains of sand such a motion as would produce the holes under discussion apparently bids defiance to everything like gravity.

Accepting the perforations then as of marine origin, let us next consider a few of their more obvious teachings.

Absence of Perforations in the Red Sandstone Cliffs:—Judging from the condition of the rocks on the existing sea-margin, it is in the highest degree probable that the red sandstone cliffs, like those composed of limestone, were formerly studded with perforations. The fact, however, that they are not now thus marked is by no means difficult of explanation; for, in the first place, these red rocks are of a soft perishable nature, and easily cut back by the sea. In all probability, the existing red cliffs are not those of the old sea-margins. The latter, with the perforations they bore, have entirely disappeared. In the second place, even if, so far as the action of the breakers is concerned, the old cliffs are still in existence, they do not retain their ancient surfaces; for it is well known, that under atmospheric agencies alone the red sandstone wastes rapidly. Prior to the formation of the South Devon railway, the hard ferruginous bands, locally termed *Pan*, which traverse the red rocks near Dawlish, projected upwards of a foot from the general surface of the cliff, and in the recesses thus formed birds in great numbers built their nests. In other words, and even supposing the Pan had sustained

no waste, the ordinary sandstone, through meteoric action alone, had lost an amount of surface greatly surpassing the depth to which any mollusk penetrates.

Amplitude of the Perforated Zone:—From the statements already made it appears that the perforations occur at various heights in different localities: from the minimum of 95 feet above mean tide at Sharkham point, to the maximum of 235 feet at Petitor. A vertical range of 140 feet.

This fact obviously suggests the following questions:—

1st. By what mollusks were the holes made?

2nd. What is the depth of water represented by, or, in the language of marine zoologists, what is the bathymetrical range of the stone-boring mollusks?

3rd. Did the vertical rise and fall of the tide in the Torbay district, during the era when the holes were made, differ materially from that which obtains at present?

4th. Do the perforations belong to one, or to more than one, period?

The Borers:—The only evidence obtainable on the first question must, of course, be furnished by a study of the existing British molluscous fauna: and to this we may safely turn, since it is eminently probable that the holes are ascribable to species which have not ceased to inhabit British waters.

According to Forbes and Hanley, the British stone-borers are *Pholas dactylus*, *P. parva*, *P. crispata*, *P. candida*, *Pholadidea papyracea*, *Gastrochena modiolina*, *Saxicava arctica*, *S. rugosa*, *Venerupis irus*, and *Sphænia Binghami*—all of them existing South Devon shells.

Pholas crispata is certainly excluded, as its transverse diameter considerably exceeds that of the largest hole. Were it certain that the inhabitant of a small shell is incapable of making a comparatively large perforation, there can be no doubt that *Pholadidea papyracea*, *Gastrochena modiolina*, *Saxicava arctica*, and *Sphænia Binghami* must be pronounced inadmissible also. Further, if the shell must accurately fill the hole, *Pholas dactylus* and *P. candida* can alone be retained. An inspection of the rocky strand, however, shows that the holes are sometimes, and, indeed, not unfrequently, larger than the shell of the living mollusk found in them. Hence, unless other grounds can be assigned, there appears to be no reason why *Pholas parva*, *Saxicava rugosa*, and *Venerupis irus*, with the two species just named, may not be regarded as the mollusks which produced the perforations now under consideration.

Before quitting this question, it is necessary to notice that aspect of it which is presented by the objection already mentioned, "that no one has ever seen *Pholas dactylus* in ordinary limestone." The authors just quoted, speaking of the species of the genus *Pholas*, say, "We have no evidence that they perforate any substances essentially harder than their shells, or so hard. The sandstones in which they occasionally occur are either friable or marly when fresh, though cabinet specimens seem solid."* It will be seen that they abstain from asserting, even inferentially, that they do not perforate ordinary limestone; for it will be found on trial that a *Pholas* shell scratches, and is therefore harder than the limestones of South Devon. Indeed, the authors go on to say, "The explanations of Necker account for their perforations in the hardest limestone." The question of hardness, however, appears to have been disposed of on the 25th of April last (1866), when a specimen of gneiss, perforated by *Pholas dactylus*, was exhibited to the Geological Society of London, by Professor T. H. Huxley.†

The following synopsis, compiled from Forbes and Hanley, shows the substances in which the British stone-borers certainly occur:—*Pholas dactylus* is found embedded in chalk, red sandstone, and lias. *P. parva* is not uncommon in red sandstone. *P. candida* is met with embedded in chalk, limestone, red sandstone, and hard clay. *Pholadidea papyracea* occurs in reddish sandstone. *Gastrochena modiolina* has been taken in masses of limestone well honey-combed by its excavations. *Saxicava arctica* is commonly found in calcareous rocks. It has also been met with in red sandstone. *S. rugosa* is found in large masses of chalk, and detached portions of limestone. *Venerupis irus* is found embedded in limestone rocks. *Sphænia Binghami* is occasionally found in limestone.

The synopsis brings out distinctly three facts:—

1st. That *Pholas dactylus* and *P. candida* have no *chemical* objection to calcareous rocks.

2nd. That *P. candida* is stated distinctly to occur in limestone.

3rd. That the list of substances is by no means an exhaustive one, *limestone* being the hardest rock it contains; whilst, as has been already stated, *gneiss* has been found to be similarly bored, and the beautifully formed perforations which, through

* "History of British Mollusca and their Shells," vol. i. p. 106. 1853.
† "Geological Magazine," vol. iii. page 264.

the kindness of my friend, Mr. Pycroft, I am now enabled to exhibit, are drilled in *flint*.

Bathymetrical Range of the Borers:—Apparently, then, there is nothing to prevent the belief that the borings were made by one or more of the five species already mentioned. We now proceed to the consideration of the second question. "What is the depth of water which they represent?"—For a reply, we turn once more to the authors so frequently quoted.

They state that "the genus *Pholas* extends from low water, between tides where the majority of species are found, to twenty-five or perhaps thirty fathoms;"* that *Saxicova rugosa* ranges from low water to a depth of twenty fathoms; and that *Venerupis irus* is an inhabitant of the littoral and laminarian zones; in other words, from between tides to a depth of fifteen fathoms. From the foregoing figures it is obvious that the bathymetrical range of the British borers, taken as a group, exceeds the vertical extent of the lithodomized zone under discussion. The 180 feet commanded by the genus *Pholas* remove all difficulty respecting the 140 feet over which, in different localities, the perforations are distributed.

The Vertical Range of the Tides:—In the foregoing discussion we have kept out of view the fact that, on account of geographical peculiarities, the tidal range alone is in certain localities almost sufficient to account for the entire difference of level of 140 feet between the highest perforations at Petitor, and the lowest at Sharkham point; and more than enough for the zone of 70 feet in the latter locality. We now propose to take up the third of the questions previously enunciated. "Did the vertical rise and fall of the tide in the Torbay district, during the era when the holes were made, differ materially from that which obtains at present?"

It is well known that the amount of this rise and fall, at any part of a channel, depends largely on the width of the channel at the point selected, as compared with that at its mouth. All other things being the same, the vertical range is an inverse function of the width. The Bristol channel, for example, between Hartland point and St. Gowan's head, is about forty miles broad, whilst at King's road it is not more than five. At Hartland the rise and fall is 26 feet, at King's road it is 46, and at the mouth of the Wye, where the estuary of the Severn is still narrower, it is 70 feet.

* "History of British Mollusca," vol. i. page 95.

The Torbay district has undoubtedly undergone geographical changes since the holes were drilled, and these may have been attended by changes in the tidal range. The nature of the latter, however, can, with a tolerable approximation to accuracy, be determined from a study of the former.

First, then, the country has been raised to a considerably higher level. The old coast line of limestone, still intact, has been carried back from the sea. Between it and the existing sea margin are considerable spaces, which were formerly sub-marine, but are now sub-aërial. The tidal area is of diminished amplitude, and the tides themselves have, therefore, probably a greater rise and fall at present than they had formerly. On the other hand, since the last adjustment of the relative level of sea and land, the waves have made considerable encroachments. They have cut, and are still cutting, the new coast line back towards the old one; but they have by no means regained the entire area over which they formerly swept. Until this is achieved, the existing conditions will be more favourable than the old for a great vertical range of the tides, which even now is no more than eighteen feet, whereas the borings, as we have seen, spread over a vertical zone of 140 feet; that is, if the distinct localities be all included.

Contemporaneity of the Perforations:—We have now reached the position that the vertical breadth of the perforated belt cannot be ascribed to tidal changes, but is not incompatible with the bathymetrical range of the existing stone-boring mollusks of Devonshire. It is obvious that this will not affect the full and due consideration of the fourth and last question, to which we now proceed. "Do the perforations belong to one, or to more than one period?"

It is scarcely possible for any one to study the geology of south-eastern Devonshire, without coming to the conclusion that the limestone table lands of the Babbacombe, Torquay, and Brixham districts are terraces of denudation. Their remarkably level surfaces, instead of being planes of stratification, consist of the outcrops of inclined beds, which, under the long continued grinding operation of breakers, have been reduced to the uniform surfaces which form so striking a feature in the scenery, and attract the attention of every one. The Babbacombe plateaux are about 280, those of Torquay 240, and the Brixham series 200 feet above the level of mean tide. Besides the foregoing, there are two other distinctly marked, though less conspicuous, terraces at the 75 and 30 feet levels respectively; the first being repre-

sented by Roundham head, on the central shore of Torbay; and the second by the shelves occupied by the Raised beaches at Hope's Nose, and elsewhere.

There are strong indications that these terraces represent five distinct and protracted periods of intermittence in a process of upheaval, which very slowly carried the entire district up to, at least, its present level, from one about 280 feet lower.

Though, on the immediate coast, there do not appear to be any very decided shelves or other marks of pause in the process of elevation between the 200 and the 75 feet terraces, there is, in a limestone cliff, on the right of, and adjacent to, the road from Torquay to Teignmouth, between the villages of Torre and Upton, something more than a mile from the sea, a very fine example of a natural arch, having all the appearance of a marine origin. Other facts corroborative of this opinion, but on which it is not desirable to dwell at present, occur in the same hill. The base of this arch is about 176 feet above mean tide.

It is an interesting fact, that, as long ago as 1848, Mr. Robert Chambers, speaking, in his "Ancient Sea Margins," of an ascent which he made from the beach to the 280 feet terrace at Babbacombe, says, " In my progress upwards, along a steep and rough, but not precipitous, acclivity, I was surprised, at about 172 feet, to come to a platform-like projection, covered with sand, and clothed with turf. Though too small a fragment to lay much stress upon, it was remarkable, in such a situation, to find it so near one of the points of elevation where such platforms, if existing at all, are to be expected."* The author, no doubt, would have thought it still more remarkable, had he known that at about a mile inland he could find a cliff with a natural arch, and other indications of marine action, at almost the precise level of his sand-covered platform.

Without dwelling on certain facts which may, perhaps, be indications of pauses at levels below that of the Upton arch, we will now proceed to collate the heights of the various belts of perforations with those of the different platforms which have been described.

On doing this, it is found that the Petitor borings are on the same level as the Torquay terraces; that those at Kent's hole, Asheldon, and Brixham, are co-equal with the platform in the last-named locality; that the highest perforations at Sharkham point are very near the level of Upton arch;

* "Ancient Sea Margins." Page 246. 1848.

whilst the lowest are no more than 20 feet above the Roundham head level, to say nothing of the probability, already alluded to, that there may be intermediate levels. In fine, each terrace is accompanied by its own zone of borings. The two sets of phenomena, each, in itself, sufficient to prove the former tarriance of the land at a series of lower levels, illustrate each other. The breadth of the entire perforated zone, instead of being a difficulty, is in harmony with the correlated facts. It is not one continuous contemporary belt, but four distinct belts—the uppermost, the oldest; the lowest, the most modern;—each formed during a protracted intermittence of the work by which a great part of that which is now Devonshire was converted to a sub-aërial from a submarine area.

It must be admitted, that unless there is evidence to the contrary, there may be another mode of accounting for the difference of level of the 280 feet, 240, and 200 feet platforms at Babbacombe, Torquay, and Brixham respectively, as well as for the different heights of the perforations. Of the three series of terraces, the Babbacombe, or highest, is the most northerly; and the Brixham, or lowest, the most southerly: that is, they become gradually lower in a southerly direction. Moreover, the distance from the first to the second is such, that the difference of level gives an inclination of no more than a quarter of a degree; whilst from the second to Brixham the fall is not quite half as much. In the first case the gradient is but one in 198; in the second, no more than one foot in one-tenth of a mile.

In like manner the most northerly perforations are the highest, whilst those furthest south are at the lowest level.

It is obvious that, unless there is clear evidence of three distinct pauses at the three different levels, it is more simple to conclude that the different platforms, notwithstanding the difference of their present heights, were formed at one and the same time, when they were parts of the same tidal strand. It will be seen, however, that if the terraces were originally at the same level, so were the perforations by which each is attended. The differences of levels, if due to inequalities of elevation in the one case, were due to the same cause in the other. So that on this hypothesis the breadth of the entire zone of borings ceases to be a difficulty.

Simple as this explanation may seem, it does not appear to be admissible: for the surface of the Daison—a hill to the west of Babbacombe, and scarcely a mile from it—is a well-marked platform at the 280 feet level; and on its slopes there

are two indentations or shelves at the requisite heights of about 240 and 200 feet. The Daison, therefore, furnishes the key to the problem presented by the more widely-separated platforms. Three terraces at different heights on one and the same hill necessarily belong to three distinct periods.

This question presents still another aspect: for let it be supposed that Devonshire formerly, like Sweden at present, underwent very slow and gradual upheaval, it is obvious that the entire coast, from the most ancient to the most modern low-water line, might have been perforated, and thus present one unbroken belt of borings, limited only by the amount of elevation, and irrespective of the upheaval having been continuous or intermittent.

Recapitulation:—Of the foregoing discussion, the following is briefly the result:—The perforations were produced probably by *Pholas dactylus* and *P. candida*, and possibly by *P. parva*, *Saxicava rugosa*, and *Venerupis irus*, whilst the district was undergoing a process of slow upheaval, which was broken by several protracted periods of intermittence.

Slow Meteoric Waste of Vertical Surfaces of Limestone Cliffs:—That approximately vertical surfaces of limestone cliffs almost bid defiance to meteoric influences is brought out with striking prominence by the fact that the work of the ancient lithodomi is not only distinctly traceable, but, in many cases, almost uninjured.

Confining attention to the highest, and therefore most ancient perforations—those at Petitor. No one can doubt that their antiquity is very great, but it is probable that few fully recognise the enormous amount of time which separates us from the date of their origin. This vast lapse of ages may be best indicated by a brief narrative, in historical order, of the prominent events by which it was characterized and divided into distinct periods, and which are recorded on the ancient cliffs and strands.

As has been stated, the Petitor perforations are coeval with the limestone platforms in the Torquay district.

After they had been drilled, and the plateaux levelled, the entire district rose slowly and gradually, until it had gained an increased elevation of about 40 feet.

Then came a protracted pause in the process of upheaval, during which the Brixham terraces were planed down, and the perforations at Kent's hole, Asheldon, and Brixham were bored.

This completed, the elevatory movement was resumed, and

perhaps continued until the level represented by the Upton arch, and the uppermost perforations at Sharkham were brought to the surface of the sea.

After this the country rose again, still slowly and gradually, and, possibly, for a very lengthened period.

The next decided indication of intermittence is about 100 feet lower level, and consists of the platform and terraces represented by Roundham head, and of the lowest perforations at Sharkham point.

Once more the district was subject to upheaval, which apparently lasted until the level of the Raised beaches at Hope's Nose and elsewhere was gained. These beaches are lodged on shelves cut in the harder rocks at from 25 to 30 feet above the sea level. Occasionally no more than a mere fragment of beach remains on a large area of rocky platform. Hence the Raised-beach pause is divisible into three distinct periods—that in which the shelves were cut, that in which the beaches were deposited on them, and that in which the latter were shorn of much of their dimensions.

These protracted operations were followed by a renewed upheaval, but to what extent it is impossible to say, further than it must have been at least 70 feet, and was probably very much more.

After it had gained the height of at least 70 feet above the level at which the Raised beaches were formed, that is, 40 feet higher than that at which it at present stands, the emerged soil was occupied by those forests whose remnants, now partly submarine and partly sub-aërial, cover the entire Torbay area, and occur so plentifully along the coasts of Devon and Cornwall. During, or subsequently to, the growth of those old woods, were formed the thick sub-aërial accumulations of angular rock *débris*, which in certain districts, especially between the Start and Prawle, immediately cover the Raised beaches, in some instances to the depth of at least 30 feet.

This forestial period was followed by a subsidence by which the entire country was carried down at least 100 feet; that is, to a level 60 feet below that which it now occupies. During this depression, the marine gravels overlying the sub-aërial accumulations, well seen near the Start point, were laid down.

For anything that appears to the contrary, this submergence may have been of comparatively brief duration. Be this as it may, it was succeeded by an upheaval which raised the country to its present level.

The phenomena which attest these changes attest also that they were produced at the cost of an enormous amount of time. The movements, both upwards and downwards, were unattended with violence or convulsion. The successive terraces of denudation are as horizontal now as when the waves washed over them; the Raised beaches have a remarkable uniformity of level, and dip towards the sea about as much as does a modern beach; and the roots of the trees are still outspread horizontally in the ancient forest soil, from which the stumps rise in a vertical direction.

The intermittent pauses were numerous, and, with one possible exception, so protracted that, in each, the waves had time to grind down to one uniform level the outcrop of hard semi-crystalline limestone; and the last adjustment of level occurred so long ago, that the breakers have been able so to cut back the cliffs, as to produce a foreshore which in some instances can be little, if at all, less than a mile in breadth. Yet in all the time represented by these varied and successive phenomena, the mechanical and chemical action of winds, rains, and frosts have failed to efface the molluscous perforations coeval with the oldest of them.

The Petitor borings are, as has been stated, older than those at Kent's Cavern; yet the latter belong to a period of higher antiquity than that in which the red loam, teeming with remains of extinct mammals, was carried into the cave; for when the holes were excavated the cavern entrances were submarine: when the loam was introduced they had become sub-aërial. The perforations originated in an era before had appeared much of the dry land of south-eastern Devonshire, which was subsequently tenanted by the mammoth, woolly rhinoceros, and their contemporaries. These have disappeared from the surface of the earth; their species have become extinct; but the borings remain almost uninjured—a companion fact for the glacial striations, of probably still higher antiquity, which rock surfaces have so faithfully retained.

ON THE RESULTS OF SOME EXPERIMENTS MADE IN HYBRIDIZING CERTAIN VARIETIES OF PEAR.

(*PYRUS COMMUNIS.*)

BY DR. SCOTT.

THE apple and pear are amongst the most important of the hardy fruits of our island, and have long held a distinguished place for their utility throughout Europe.

The former is supposed to be indigenous to our own country, and to have its origin in the crab (*P. acerba*), while the latter is believed to belong to the south of Europe, or it may be to the fruitful valleys of Kurdistan, where, with most of our garden fruits, it now may be found growing, in thickets, apparently wild. It is possible, however, that even here it may only be as the remains of former gardens, whose owners have long since passed away.

The importance of these fruits has led greatly to their increase, and to much improvement on their original character, and hence we have now many varieties of each. It is for the purpose of recording some experiments made for increasing our varieties of pears, that my present paper is intended.

The Romans possessed about thirty-six varieties of pears. We now enumerate several hundreds.* Among those whose names stand most prominent, as producing successful varieties, are Mr. Knight, Professor Van Mons, Mons. Leon le Clerc, M. Deuguesse, Major Esperen, Mr. Rivers, and the Rev. John Huyshe of our own county. It is to some experiments made by this last-named gentleman that I am desirous of directing the attention of the Association for a few minutes.

About thirty years ago, Mr. Huyshe thought that if the best qualities of Gansells' Bergamot could be united with those of Marie Louise, the result would be a great improvement on either of these pears. I may mention here, that connoisseurs in pears estimate their excellence chiefly by two qualities,

* Don enumerates 677 varieties of *P. communis*, and 1400 of *P. malus*.

viz., the character of their flesh and the richness of their flavour. Now, the Marie Louise has an excellent flesh but with a certain insipidity of flavour, while Gansells' Bergamot has a somewhat coarse-grained flesh, but possesses a highly aromatic flavour.

Mr. Huyshe, therefore, hybridized these pears by impregnating the pistils of the Marie Louise with the stamens of the Bergamot, and the result of this cross was three very fine new pears, known now amongst horticulturists as Huyshe's Victoria, Huyshe's Prince of Wales, and Huyshe's Princess of Wales. These have been designated by Dr. Hogg as the "Royal pears."

The objects of Mr. Huyshe in this experiment were completely obtained. He secured the melting flesh of the Marie Louise, combined with the high flavour of the Bergamot. These pears all differed from their parents, and in certain respects from each other, thus proving themselves to be three distinct varieties; at the same time they all possess the combinations of improved flesh and flavour.

The Victoria is the hardiest in constitution, and is the most prolific bearer. The Prince of Wales is the largest in size, and of somewhat higher flavour than the Victoria, but it is not so prolific. The Princess of Wales is more delicate in constitution, but of very high excellence in flavour, as well as flesh. Indeed, in this respect it stands in the very highest place amongst our very best varieties of pear. They all possess one quality in common, of great importance; they will remain two or three weeks after becoming ripe before they run into decay.

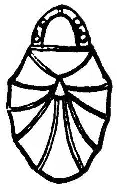
The experience of the Belgian pomologists—who, by the way, have been by far our largest experimenters in this branch of horticulture—has been, that about one in ten out of their seedlings only were found worth cultivating. In Mr. Huyshe's case all have been found excellent.

The success which he had in this attempt led him again to make another experiment, and to the results of this I am anxious to draw your attention.

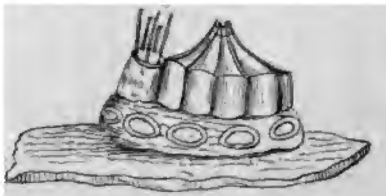
On this occasion Mr. Huyshe chose for parents the two well known varieties of pear, viz., the Beurre d'Aremberg and Chapmen's Passe Colmar: both of excellent quality, but the latter of smaller size than the former. In this instance, however, he made two experiments; for in one case he took the stamens of the d'Aremberg, and applied them to the pistils of the Colmar; and in the other he took the stamens of the Colmar, and applied them to the pistils of the d'Arem-

berg. The results of this double cross have been remarkable. It might have been thought, that the parents being the same, and the circumstances under which each were brought together being as nearly as possible the same, excepting in the difference above alluded to, that the results would have been pretty equal. Such, however, has not been the fact. In the case where the d'Aremberg was the mother, the offspring is large, and is a fruit of excellent quality, known now as the Prince Consort. On the other hand, where the Colmar was the mother, the offspring (two in number) are small, but of good flavour.

From these experiments it would appear that the size of the progeny (in pears) depends mainly upon the mother, while the flavour depends more upon the father. Of course these are very limited experiments, and should not, therefore, be taken for more than they are worth; but in these days, when the question of "species" is of such interest, I have thought them not unworthy of recording in our transactions, as they certainly point in a direction indicating that from a single pair of ancestors we may have offspring differing very widely from each other in some of the most prominent characteristics of the family. Breeders of all kinds know that the influences of male and female differ considerably upon the offspring, but I am not aware that any definite laws have as yet been eliminated. In the hope, therefore, of adding one fact to the many that must be accumulated, before we can arrive at any true knowledge of the subject, I have ventured, with Mr. Huyshe's concurrence, to bring his experiments before the Association.



I



II

Lepralia innominata variety.

I. Cell seen in front.
II. Cell sideway, showing the perforated base,
all enlarged.

E. Parfitt del.

FRESH-WATER POLYZOA.

BY E. PARFITT, M.E.S.

THE study of the Fresh-water Polyzoa has been very much neglected in this country; at the same time the marine species have had their full share of admirers, as the beautiful monographs produced by Ellis in 1755, and Ellis and Solander; and long after these authors followed Dr. Johnston, bringing down the vista of time all that had been done, all the papers and information that had been written, up to the time of the publication of his monograph: this was a great achievement, and one that was fully acknowledged by those best qualified to judge of such labours.

In 1844 one of the members of that most indefatigable family in the study of natural history, Mr. R. Q. Couch, published the Zoophytes of Cornwall, a very useful work; but in this, although it is nearly exhaustive as far as marine species are concerned, only one fresh-water species is enumerated, viz., *Fredericella Sultana;* and Dr. Johnston, in his last edition, published in 1847, has only described five species, and this is for the whole United Kingdom.

At the same time, M. de Van Beneden and M. de Gervais had been directing their attention to the fluviatile species of the continent of Europe; and Dr. Leidy to those inhabiting the rivers and lakes of the United States of America; and last of all we have the splendid monograph of all the species then known, by Professor Allman, whose labours have brought together all that was known of these exceedingly interesting animals, from every part of the world, where these creatures had been studied. In this the Professor has enumerated and described twenty-two species. This does not appear many when we consider the large tracts of water, both of lakes and rivers, that could be explored on the surface of the globe. This very small number, I think, shows that there is still plenty of room for more observers, and I might add that I think a wide and rich field lies open to them.

Now, in my very limited range in the neighbourhood of

Exeter, I have discovered five species, and two out of these five are new to science, bearing out what I before said, that we want more observers, and closer observation. For if a very limited area, like that above described, has yielded two new species, by the same rule the whole county ought to give us many.

The habits and modes of propagation of these elegant animals are exceedingly interesting, most, if not all of them, so far as is at present known, are *annual*, or are produced afresh from what are termed *statoblasts*, egg-like capsules, produced in the tubes or polypidoms in which the animals live.

During the summer months some of the species are gemmiparous and oviparous, but towards autumn, and, indeed, even at midsummer, they also produce statoblasts; these, I must say, I have not yet seen developed into young zoophytes; but Professor Allman says: "In the mode of development of the statoblasts from the funiculus of the polypide, we are involuntarily reminded of the development of chains of salpha-buds from the stolon of the solitary salpa. And again, if we attempt to correlate the individual phenomena now described (speaking of the mode of self-division or gemmation) in connection with the reproduction of the polyzoa, we cannot but be struck with some remarkable analogies which would seem to bring the whole process of generation and gemmation in these animals within the domain of the so-called "law of alternation of generation." But for a further insight into the mode of reproduction and development of these interesting animals, I must refer you to Professor Allman's monograph.

The two species that I now wish to draw your particular attention to were discovered by myself in the neighbourhood of Exeter, and they belong respectively to the two divisions into which the genus Plumatella is divided, viz., those with the upper portion of the cœnœcinum, diaphanous, or sub-diaphanous, and those with the walls of the tubes opaque.

1st. We have a species I have named *Plumatella Limnas.* I met with it attached to the valve of *Anodon Cygneus*, in the canal between Exeter and Topsham, June 23 of this year. The cœnœcium is adherent its whole length, irregularly branched, the branches growing mostly in pairs, dilated towards the orifices, the latter not occupying the extreme ends of the tubes. The upper half of each tube is covered with a transparent membrane, a part of the tube itself; this, under a binocular microscope, with artificial condensed light, is seen to have a line running the whole length of

each tube, made up of minute grains of a yellowish brown colour; the orifice of the polype cell is entire; the cell itself is hyaline, and very thin. Inside the cell is seen another, even more transparent, and thinner than the other; this can be elevated or depressed at the will of the animal. The inferior half of each tube is opaque, and made up of pentagonal cells; this can only be observed when the tubes are broken down, and then only under a high magnifying power; but it appears to be a new feature in the economy of these animals in building up their polypidoms. The outside of these reticulated walls are coated with extraneous matter, collected in small brownish yellow grains. The polype cell, as before stated, is transparent: the etocyst have generally three or four rings or constrictions, which give them rather an ornamental appearance. The animal is white, and has from 50 to 54 tentacula, and the calciform membrane is festooned.

The *Statoblasts* are very distinct, a character considered by Professor Allman of much importance. They are yellow, reticulated, with a comparatively narrow purple rim; inside this, between the rim and the ova cell, is a narrow dark brown line. Some of the Statoblasts had a slight constriction on one side, which gave them a somewhat reiform outline.

Now, the most remarkable feature in this species is the transparency of the superior half of each tube or polypidom, showing the thickness and density of the inferior half, that it forcibly reminds one of a tunnel with brick or stone walls, latticed on the inside, and painted white, with a glass roof, and a very faint line running along its roof. The nearest ally to this species at present known is *P. emarginata*, but their allegiance is not so close but that they may be instantly distinguished.

The next species I have to draw your attention to is one I have named *Plumatella lineata*, from the longitudinal lines on the tubes or polypidom.

The Cœnœcium is creeping, closely adherent, except the polype cells, somewhat radiating, reddish horn colour, longitudinally striated with from eight to ten dark brown striæ, and with a few bits of similar material to the lines scattered over the tubes. These lines, in most instances, run half way up the polype cells.

The cells are barrel-shaped, white, and transparent, showing distinctly the animal within; their orifices round and entire, each having five or six distinct dark brown annulations, and are slightly constricted at each annulus. The cells are frequently produced in pairs. Animal white, with a faint

yellowish tinge, having the longest tentacles of any species that I have seen figured or described. I could not discover any calciform membrane. Tentacula 62. The Statoblasts, dark reddish brown, with a broad yellow annulus.

I met with this fine species under the leaves of water-lilies, in a pond in Mr. Veitch's old nursery, on the Topsham road, near Exeter.

The habit of this species is like that described by Van Beneden, and named by Professor Allman, *Plumatella stricta;* the form of the statoblasts is the same, but the description appended is so brief that I cannot pronounce the one we have under consideration and *stricta* to be the same. Nothing is said of the peculiar lineated appearance of the tubes, as seen in this, which, I think, mark it at once as distinct.

The animal has a peculiarity of withdrawing itself half within its cell, so that only its long tentacles are free; these are kept in constant motion, waving and twisting about like a bundle of small worms, and reminding one very much of the class of marine annelids belonging to the Terebellidæ. This constant motion is kept up by the animal whilst it is in search of food; the rows of cilia are at the same time kept in full play.

Before concluding, I would wish to draw your attention to a remarkable variety of *Lepralia innominata*, (*see fig.*,) which I met with in my investigation of the marine Polyzoa of this county.

Dr. Johnston says of this species, that "the ribs, or furrows of the cells, appear to diverge sometimes from a central umbo, and sometimes from a medial line." This, you will observe, is the case; but he does not mention the cell as being perforated in the centre, round which the ribs converge; and in some specimens they stand up very conspicuously around this aperture, like palisades.

Mr. Hincks mentions another variety, in which "the central umbo is wanting; and along the furrows are set rows of punctures, which ran continuously across the front of the cell." This variety, he says, closely resembles *L. radiata, Moll.* From the above you will see that this species is liable to considerable variation; but I hold that every well marked variety should, if possible, be noted, not only as regards the zoophytes, but in all cases where they may occur. For we see here species, or at least what we are pleased to recognize as such, breaking away into varieties, radiating, as it were, from a common form into extremes in another direction.

It is a remarkable thing that, throughout the whole range

of the animal kingdom, you find here and there species with apparently an almost unlimited range of variation; one or two species in a group or family will have this eccentricity, while all the rest will remain fixed to their normal condition, or at least what we look upon as the normal condition. Is it that some are endowed with a greater degree of plasticity, and therefore conform to circumstances over which they appear to exert no control? Others again do exert an influence over the peculiar conditions to which they may be subject.

Now this variety under consideration not only differs from the supposed type in the elevated or tent-like roof with its perforated centre, but the walls of the cells are twice the height of the supposed normal form, as if one cell had been built upon another, and the bottom one perforated at the sides with elliptical holes. These holes, it will be observed, are not accidental, but are highly finished, with a polished rim round each of them; what their use really is I cannot pretend to say, not having seen the animal alive. But similar places exist, although not so many, in some other species of *Lepralia*, and are termed *avicularia*, or orifices to which the remarkable bird's-head processes are attached. These birds'-heads, as is well known to the investigators of this section of the animal kingdom, are generally placed so as to guard the orifice of the cell, and protect the animal or polype from molestation; in fact, they are private police, or watchmen. The only instance of the avicularia being so far removed from the mouth of the cell, I met with in a specimen of *membranipora Flemingii*, from the Channel Islands. But in this there are not so many openings that I cannot conceive so many birds'-heads attached to a single cell; the greatest number I have ever known is four; these were attached to a cell of *Lepralia nitida*, from our own coast. The only supposition I can fall back upon is this, that the whole specimen is abnormal, and that more avicularia have been produced than was of necessity. The first glimpse we have of *Lepralia innominata* in the scale of creation, is that figured in Professor Busk's *Polyzoa of the Crag, pl. 4, fig.* 2; and this is the variety mentioned by Mr. Hincks, with radiating ribs, and the interstices dotted or punctured; so that one form of this species has been handed down to us for a long period of time. This may be the oldest or primitive form, at least it is the oldest at present known to us, and ought, perhaps, to be looked upon as the type of the species. At the same time it would be dangerous to alter the specific value of the one pronounced to be, or considered to be, the typical form, for that which,

before this was discovered, was supposed to be the progenitor of the species. For the next investigator of the crag polyzoa may discover to us our now supposed normal form. From this you will see what difficulties there are in the way of arriving at a true and definite distinction of what is a species, and what is a variety.

"Who shall pronounce, when doctors disagree."

RAISED BEACHES.

BY. W. PENGELLY, F.R.S., F.G.S., ETC.

Introduction:—In the present communication, instead of aiming at description, my object is to call attention to certain facts which, perhaps, have scarcely received all the attention to which they are entitled.

By a *Raised Beach* is meant an accumulation of sand, or gravel, or both, aggregated by the waves, with or without embedded shells, unconnected with the existing tidal strand, and at some height above the reach of the most violent waves even at the high-water of equinoctial spring-tides. Such beaches are evidence, of course, of a change in the relative level of sea and land; a change which, it must be unnecessary to remark, geologists ascribe to an upheaval of the land, not to a depression of the sea; the level of the latter being regarded by them as perhaps one of the least unstable things in our changing world.

Being thus connected with geological dynamics, it becomes eminently necessary that observations on Raised beaches should be made with philosophical care, in order that the alleged facts, and the conclusions drawn from them, may be perfectly trustworthy.

Stratified Blown Sand, with Marine Remains:—Those who are familiar with any very extensive and varied coast line, must be aware that, without great caution, an observer is in danger of giving the appellation of Raised beaches to certain phenomena which are by no means entitled to it. Distinctly stratified accumulations of sand, unquestionably of marine origin, crowded with marine shells, and far above the utmost reach of wave or tide, may or may not be Raised beaches. They may have been formed beneath the ocean, and subsequently upheaved with the district generally; or they may be simply masses of blown sand, formed precisely where they are found. To illustrate and demonstrate this proposition it is not necessary to do more than mention the following facts:—During a visit to the Land's End, in July, 1864, with my friends, Dr. Scott and Mr. W. Vicary, as we

ascended from Sennen Cove to the summit of the cliff overhanging Whitesand Bay, we observed, at what we guessed to be 200 feet above the strand, a thick and widely-spread accumulation of fine sand, in distinct laminated beds, and containing a large number of marine shells. Most of the latter were of small species, but amongst them was an occasional limpet shell of by no means very diminutive dimensions. In fact, we detected what, without the opportunity of careful study, would be generally regarded as a fine example of Raised beach, and which, indeed, we at first considered it.

Being somewhat familiar with the veritable Raised beaches of Devon and Cornwall, we were struck with the fact, that whereas these are commonly about 30 feet above mean tide, the mass before us was at least six times that height. Proceeding to a minute inspection, we found that a considerable number of common land shells were mixed with the marine forms, and that here and there were interstratified discontinuous bands of partially decomposed vegetable matter. The solution of the problem was soon supplied. For some days the weather had been very dry; the fine sand, for which Whitesand Bay is famous, was quite incoherent, and easily transportable; and a smart on-shore wind, which was blowing at the time, brought up from the strand below a sufficient number of grains of sand and minute shells to satisfy us that this excellent imitation of a Raised beach was due to atmospheric action alone; especially when we remembered how violent and how frequent are the gales to which the Land's End district is subject. Here and there the sandy accumulation bore patches of meagre herbage, which, on being covered with sand, would produce new examples of incorporated bands of vegetable matter.

I have subsequently noticed, in other, though less elevated localities, as on the Warren at the mouth of the river Exe, similar accumulations, some of them even containing "ripple marks," and "diagonal stratification;" and have thus been taught to seek in a reputed Raised beach marine shells or pebbles too heavy for atmospheric transportation, or some other fact sufficient to establish its claims to the name it bears.

Are contemporary Raised Beaches necessarily on the same level?—It cannot be necessary to observe, that the foregoing remarks are by no means intended to foster a scepticism respecting the existence of true Raised beaches. It must be impossible for any one who has studied the numerous and

Fig. II.

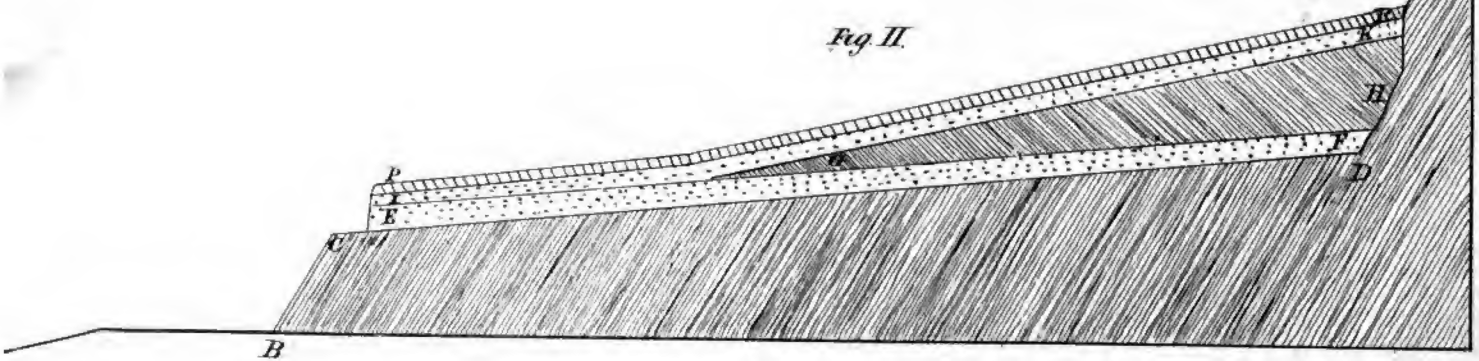
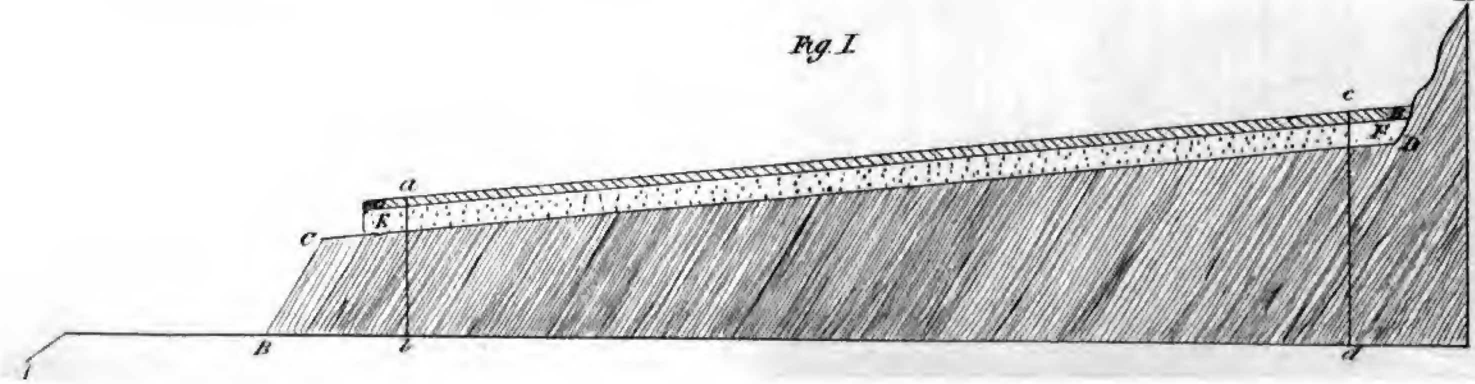


Fig. I.



fine examples along the coasts of Devon and Cornwall, especially in the Torbay district, to entertain a doubt that they are what every geologist has pronounced them—terraces of deposition accumulated by the waves when the country was at a correspondingly lower level. There appears, however, to be a common fallacy respecting Raised beaches in general. Not only is it held that those are contemporary which are at the same height above the sea, but there is a prevalent notion that those which belong to the same period are necessarily at the same level: or, to put the latter proposition in another form, that Raised beaches having a marked difference of level belong to different eras.

It is obvious that the proposition, that contemporary Raised beaches must be at the same level, rests on three assumptions: 1st. That existing sea beaches have one uniform level. 2nd. That all parts of an upheaved district have been equally raised. 3rd. That the coast has everywhere endured the same amount of waste since the upheaval.

1. (*a.*) Though it is, no doubt, true that adjacent parts of the surface of the same beach, at equal distances from the still-weather water line, must be very nearly on the same level, marked differences are not unfrequently observable on comparing the extremities of any very long beach. If in any district, for example, the most powerful and most prevalent waves are those thrown ashore by a south-westerly wind, and if the trend of the coast be from south-west to north-east, the shingle will travel from the former, and be heaped up at the latter extremity of the beach. Here it will be above, and there below the average level; and so on for other winds and similarly related coast lines.

Again, if a beach, composed of fine sand, range from north-east to south-west, it is eminently probable that the sand will accumulate in greatest quantity and be highest at the end in the former direction, and be lowest at that in the latter: for south-west winds being commonly wet, and those from the north-east being usually dry, the sand under these will be, but under those will not be, transportable. Without denying that occasionally it may be blown towards the north-east, there can be no doubt that the balance will be very largely in favour of the opposite direction. A well-marked instance of this action occurs in Morte Bay in North Devon.

(*b.*) Further, it sometimes occurs that the different inlets of the same bay are occupied by beaches which, in consequence of projecting headlands, are completely unconnected, and reach very different levels. Some of them remain un-

visited by the sea, except at the juncture of violent waves at spring-tide high-water; whilst others are never dry, even at the lowest retreat of the tide, but have, as a minimum, a depth of from ten to twelve feet of water over them. Instances of this kind are to be met with in the various divisions of Torbay, where the maximum rise and fall of the tide in still weather amounts to fully 18 feet, and where there is a series of recent beaches differing fully 30 feet in level. Hence, were the Torbay district raised uniformly 40 feet, amongst other results, there would be at once a series of contemporary Raised beaches, some of them no more than ten, and some as much as forty feet vertically above the utmost reach of the highest tide, with others at intermediate levels; and the extremes of elevation would not be necessarily or probably at the extremes of distance.

(*c*.) Moreover, the level of an existing beach is by no means constant. It is anything but a rare case to find a strand suddenly and, so to speak, capriciously raised or lowered as much as ten feet above or below its former level. As examples, I may mention that a few years ago pebbles were suddenly cast ashore on a small beach in Torbay, between Brixham and Berry Head, in sufficient numbers to raise its surface from six to seven feet above the level of that which for many years previously had undergone no change. From that time to the present the new level has been retained. Again, during the spring of the present year (1866), a single tide swept from the entire length of Slapton Sands, extending along the coast, between Dartmouth and the Start Point, for a distance of three miles, so much shingle as to lower the level fully seven feet.

2. Districts are raised either by sudden or by gradual upheaval—the former being probably more local and less frequent than the latter. It is not easy to suppose that by paroxysmal action every part of an extensive district would be equally uplifted, especially when, as in Devonshire, the irregular action of inequalities in the elevating force would be facilitated by numerous joints and other divisional planes traversing the rocks in various directions.

Probably the best known example of slow, gradual, and continuous change of level is that of Sweden, especially on the shores of the Baltic and the Gulf of Bothnia, where, as is well known, the movement is by no means uniform in amount or in direction. Sir Charles Lyell states, that "in proceeding from the North Cape to Stockholm, the rate of upheaval diminishes from several feet to a few inches in a

century. To the south of Stockholm the upward movement ceases, and, at length, in Scania, or the southermost part of Sweden, it appears to give place to a movement in an opposite direction."* It is obvious, therefore, that two contemporary beaches, one at the head of the Bothnian Gulf, the other on the immediate north of Stockholm, even if originally at precisely the same level, would be carried, in process of time, by one and the same upward movement to very different heights.

3. The tidal strand, whether a terrace of denudation or of deposition, instead of being horizontal, is always more or less inclined towards the sea. If, therefore, different parts of the platform on which a beach was deposited, and also of the upper surface of the deposit itself, were respectively on precisely the same levels at equal distances from the water line, it would by no means follow that, if such a beach were uniformly raised, such parts of it as might remain after a lapse of ages would necessarily be on the same level. For, since in different localities the encroachments of the sea are very unequal in amount, in one place the beach might be cut back but little, in another it might have so retreated as to be on the verge of annihilation, whilst an intermediate portion might be entirely destroyed; and if, to make the case complete, a sub-aërial accumulation had been thrown down on the remnants from adjoining heights, so as to leave vertical cliff sections alone exposed, there would result two unconnected raised beaches, one perhaps thirty feet higher than the other, and which, though contemporaries, might be appealed to as proofs of two protracted periods of intermittence in a process of upheaval.

By way of illustration:—In the diagramatic vertical section (fig. I), at right angles to the coast line, let AB be the high water level; CD an ancient tidal strand, dipping towards the sea, and raised so uniformly as not to affect its inclination; D, 30 feet above the level of C; EF, a sea beach or marine bed; and GH, a sub-aërial accumulation derived from the height I, or elsewhere. If in one district the waves had cut the cliff no further back than to the line *a b*, whilst in another they had encroached as far as to *c d*, the "Raised beach" exposed to view in the latter case would be almost 30 feet higher than that in the former; and if these remnants were some distance apart, and the intermediate beach either concealed or entirely destroyed, there can be little doubt that many, probably most, geologists would regard them as being

* "Principles of Geology." 7th edition. Page 506. 1847.

of different ages, and as betokening two distinct pauses in a process of elevation.

An instructive section, bearing very closely on this hypothetical case, may be seen on the coast between the Start and Prawle Points, in South Devon.

In fine, mere inequality of height in two distinct raised beaches, when not excessive, cannot be taken as unchallengeable evidence that the beaches belong to distinct periods.

Are Beaches Raised to the same Level necessarily contemporary?—No doubt, fallacy lurks much less frequently in the proposition that Raised beaches having the same height are contemporary. Nevertheless, even this must not be accepted without due consideration. Suppose (fig. II) a Raised beach, EF, to be partially covered with a sloping talus, G H, of subaërial matter, but which leaves its sea-ward margin, from E almost to G, completely exposed. Then let the district be again submerged; a second beach, IK, of materials identical with those of the first, superimposed on the entire area; and the whole re-elevated above the sea. It is obvious that beyond the talus the two beaches will be in contact and indistinguishable, and if the general surface be covered with soil and greensward, PR, so as to leave the cliff section alone exposed, the fact of two beaches would never be suspected unless the sea should make an inroad, transversely to the general coast line, sufficient to show them with the interbedded wedge-like talus. Now the section already mentioned, between the Start and Prawle, shows that this is much more than a hypothetical case. It actually reveals the succession of changes which is here supposed.

Unequal Distribution of Raised Beaches:—It is occasionally remarked that Raised beaches are by no means uniformly distributed; some parts of the old coast line being destitute of them, whilst in others they are of frequent occurrence. This well-established fact ought not to excite surprise, for we find the existing coast in some places shelving very gradually beneath the sea, whilst in others it springs very abruptly from deep water and rises into lofty precipices. For example, an upheaval of south-eastern Devonshire to the extent of thirty feet would almost annihilate Torbay by converting it into dry land, whilst of such part as remained, the well-known terminus, Berry Head, would be still the southern boundary. Very much of the bay would be transformed into a Raised beach of great amplitude, but the headland would remain as bold and abrupt as ever. Its vertical surface might disclose a zone of lithodomous perforations,

but otherwise, it would supply no evidence of the upheaval; for, judging from the fact, that during the last war between England and France, the *Ville de Paris*, a first-rate ship, passed so near to this headland that a gentleman standing on the headland threw a half-crown on board, not only have the waves failed to lodge a pebble at the existing sea level, but they have not even commenced the formation of a shelf on which to place it.

Again, many Raised beaches have been destroyed. In south-eastern Devonshire they do not occur east of Hope's Nose, the northern horn of Torbay; but thence to the Prawle they are numerous. In other words, they are met with only where the coast consists of hard durable rocks. East of Hope's Nose the Devonshire coast consists almost exclusively of Triassic rocks—all comparatively perishable; whilst in the other direction it is formed of limestone and other Devonian rocks, or of the still harder metamorphic schists.

There can be no doubt, that when the country stood at the level indicated by the Raised beaches, the waves cut a platform in the soft red rocks, and on it lodged deposits of sand and gravel, as certainly as in the less-easily eroded Devonian and metamorphic strata. Indeed, it is probable that such terraces of denudation and deposition were of greater extent in the former than in the latter rocks. But no sooner had the country been raised to a higher level, than the waves attacked the new line of coast, gradually cut back the cliffs, and thus formed a new and lower platform. All other things being the same, the retreat of the cliffs before the waves would be rapid in proportion as the rocks were yielding; and hence the Red sandstone district would be shorn of its Raised beaches long before the harder and less perishable rocks would be deprived of theirs.

In conclusion, and by way of recapitulation, my desire in this communication has been to call attention to the facts:—

1st. That accumulations of Blown sand occasionally assume the character of Raised beaches.

2nd. That it is not safe to conclude, in the absence of other evidence, that Raised beaches differing in height by as much as even thirty feet necessarily belong to distinct periods.

3rd. That it is possible that what, in a small vertical cliff section having the direction of the coast line, appears to be but one Raised beach, may really be two.

4th. That, all other things being the same, Raised beaches are likely to be most numerous on a coast composed of durable rocks.

ON THE TRACES OF TIN STREAMING IN THE VICINITY OF CHAGFORD.

BY G. WAREING ORMEROD, M.A., F.G.S.

To most of the audience it is probably unnecessary to describe the process of "Tin streaming;" it will suffice to say, briefly, that gravels containing tin ore, either in fine powder, or in stones, occur in Cornwall and Devon, generally laying upon a "shelf" or surface of rock, and covered by clay, or gravel, and peat: a very great variation occurs, both as to the depth at which the "stream tin" is found, and the material by which it is covered. The gravel containing tin is washed away from the ore by being agitated on an inclined plane, down which a rapid stream of water is taken; and hence the the name of "stream tin," and "stream works," is derived. This method of procuring tin was practised extensively in former days, both in Cornwall and Devon; in the last named county but few if any stream works now exist, although numerous remains of these works there abound. The traces of the labours of "the old men" are to be seen near the banks of most of the rivers and brooks bordering on Dartmoor; to a notice of those laying near the upper waters of the Teign, near the old stannary town of Chagford, the following pages will be devoted.

The Stannary Parliament of Devon was composed of jurors returned by the Stannary towns of Chagford, Ashburton, Plympton, and Tavistock. Each of these Courts returned 24 jurors, whose united act bound the rest of the county. The written customs were determined in this manner in Parliaments held in 2nd, 24th, and 25th Henry VIII., 6th Edward VI., and 16th Elizabeth. The Stannary Courts are mentioned in two charters of king John, and their privileges were confirmed by charter of 33 Edward I., and by private statutes of 50 Edward III., and explained by 16 Charles I., cap. 15; but their jurisdiction and manner of proceeding was revised by the 6 and 7 William IV., cap. 106, (passed in 1836,) and the court of the Vice Warden has now jurisdiction in both Cornwall and Devon. Chagford

was made a Stannary Town, in 1328, by patent of 2nd Edward III.; and from its being selected as one of the places at which the courts were held, it may be presumed that the tin workings in that vicinity were then extensive; the traces of stream works show that such was the case as to that description of work, and to these superficial excavations the labour of the tinner appears to have been almost entirely confined, as very few traces of mines and levels exist in that district.

At Chagford there are a series of parish accounts, which extend, with unfortunately very many large blanks, from 1480 (20th Edward IV.) to 1597 (39th Elizabeth); from these the parochial arrangements, and many highly interesting matters connected with both the general and social history of the time can be gleaned, and amongst these are the names of various tin works that belong either to the parish, or the guilds that then existed there, and also the costs of work, and profit and loss. Most of these works were on the granite in the higher part of the valley of the Teign.

The North and South Teign both rise on Dartmoor; the North Teign, which is the chief stream, rises in a morass, (about 1600 feet above sea level,) the western side of which reaches to the river Dart; from this point the land falls rapidly; at Teignhead bridge the height is 1449 feet, and at the eastern side of a broad level, where, after receiving the Walla brook by the Tolmen, the North Teign enters a gorge in the granite hills, the height is 1192 feet. Above this level the course of the river is in a deep valley, over broken granite, or ledges of that rock. The broad level, however, appears to have formed a swamp or shallow lake; and the courses of both the Teign and Walla brook have there been excavated, as is clearly shown by the sides of both of them, which are formed of perpendicular walls of granite: if these cuttings were closed the Teign would flow into the level, which would again become a morass. These cuttings are probably the work of the tin streamer, of whose labours traces there exist. The North Teign, after leaving this level, enters a narrow gorge which extends to Gidleigh park, the hills on each side occasionally rising to about 200 feet above the level of the river. Near Gidleigh bridge (670 feet above sea level) the Blackalton water falls into the Teign, which, after passing a level, probably the site of an ancient lake, joins the South Teign at Leigh bridge, and the combined stream thence flows by Holy street, Chagford, Rushford, Easterbrook, and under Dogamarsh bridge to Hunts Tor, where the Teign enters a narrow gorge, and leaving the granite flows over the carbona-

ceous rocks. To this point the course of the Teign has been over granite, the upper part of the Blackatton water runs on the carbonaceous beds above Throwleigh. The Easterbrook also rises on the carbonaceous beds, and the high ground to the left along its course is mostly composed of that rock.

By the side of the Teign between Fingle bridge and Hunt's Tor there are traces of Tin streaming, but with the particulars I am not acquainted. The works at Dogamarsh are mentioned in the will of John Westcote, of 20 November, 1522. (14 Henry VIII.) At Parford, on the hill side to the north of the Teign, are the remains of very extensive works, which extend over both the granite and carbonaceous rocks; in 1553 (7 Edward VI.) works at Parford, and "the deep works at Parford" were conveyed to William Knapman. To John Knapman in 1559, (1 Elizabeth) the works at Bradford were conveyed. Bradford Pool, to the left of Easterbrook, lays on the edge of the granite and carbonaceous rocks, and is formed by water which is dammed up in the excavations, in consequence of the stoppage of the adit which passes under Shilstone Farm, and near the well known Cromlech. The accumulation of water known as Bradford Pool has taken place within the last 70 years. A trial shaft was sunk about 20 years ago to the north west of Bradford Pool, on the carbonaceous beds, but ore was not found. The ground below Bradford Pool and Shelstone Farm, and nearly adjoining Fentown, has been streamed, and is probably the work mentioned in the old accounts as Shelston Venn. One half of these works belonged to Chagford parish, and in 1539 (31 Henry VIII.) the wardens of St. Michael received 3s. "*pro stanno Shylestone Venne at Rodemas.*" (3rd May.) This work was carried on up to 1580 (23 Elizabeth); the average annual receipts were 7s. 8d., the payment 4s. 1d.; the greatest receipts were in 1580, when they amounted to 15s. 8d.

On the right bank of the Easterbrook, a little lower down the stream, there are many traces of workings, being probably those "In Rushford and Chagford," conveyed in 1540 (31 Henry VIII.) to William Haule. Returning to the Teign, on "Coney Ball," part of the Rushford estate, we find works, which are doubtless those mentined as "Coney Park," in the account of St. Michael's wardens of 1539; these are only mentioned five times, and at the last entry in 1567, the receipts were 1s. 7d., the payments 5s. On a cross valley which joins that of the Teign on the right bank, there were works at Lagland and Slankam Moor belonging to St. Katherine's wardens; of the first there is no mention in the accounts,

from the last one shilling was received in 1531. At Week, in this valley, trials have been made for tin: and the remains of some old levels exist. At Westcote, near Chagford, there are deep and wide excavations on the hill side, known as "The Higher Liners beam." Between this place and Chagford the fields are seamed by the workings, "Bowre Haycombe," belonging to St. Katherine's wardens, "Bowre Haydown," belonging to St. George's wardens, and "Broomhill," belonging to the parish, were probably here situate: of the two first there is no mention in the accounts; for the expenses of the last, the parish paid in 1531 8d., and in 1532 1s, and received nothing. In 1525 (16 Henry VIII.) 1s. 4d. was received from a work, "*subter pontem de Chagford,*" and in 1532 7d. from "Bowland" by Chagford bridge; the greatest amount received from the works at Chagford bridge was 7s. 2d., and the payments were 5s. 8d.

Chagford common has been streamed, and tin is occasionally found when drains are cut in the fields along the side of the brook that flows from it to the Teign.

At Leigh bridge the North and South Teigns join. Near Yadworthy (about A.D. 1580) there were workings at Ledyet Lyny, but there is no entry of either receipts or payments.

As blocks of quartz, micaceous iron, and hematite, occur in that vicinity, it is probable that a lode there exists. On the neighbouring farm of Corndon there are two fields, known as "the Higher Lode Hill," and "Greater Lode Hill," but no information can be gathered respecting any works on those spots. Near Metherell, at Heystone, and Windlace, and higher up on the South Teign, there are traces of workings, and trials have been made at a recent period; and on the summit of the ridge, at Waterdown Tor, are the traces of what were probably the workings at "Waterdown Rugge," mentioned in the will of John Westcote (of 1522).

This ridge divides the watersheds of the Teign and Dart, and on its southern side are the trials at Caroline, and the tin mines of Vitifer and the adjoining district.

The North Teign, above Leigh bridge, is mostly in the parish of Gidleigh, and I have not been able to collect particulars as to the old workings, the traces of them exist along the river's side, and the extensive works that have been carried on at the broad level above the Tolmen have been already noticed.

The parish owned works at Bushdown, near Vitifer, Cherebrook, in the valley of the Dart, and other places, which were unprofitable; it had works at Bubhill, of which the situation is not known, but was probably either in Gidleigh or Throw-

leigh parish: these works appear in the accounts from 1481 to 1572. In 1555 the parish paid £1 13s. 7d. for the sixth part of a half a dole of Bubhill, and this appears to have been the most profitable work belonging to it, although occasionally the outlay exceeded the receipts. The works at Tawmarsh, below Steeperton and Cawson, were the most distant, and from thence the receipts appear to have covered the expenses. The names of many other workings could be added, but the above will show the character of those carried on in the days of "The Old Men;" and it has been considered proper to notice the above rather fully, to show that fair examples have been given.

A memorandum of about the date 1593, written in the old accounts, amongst other tythes which had been paid from time immemorial at Chagford, mentions—"For every spallier a shovell penny." A spallier was a man who was employed in getting tin.

The accounts, as before mentioned, commence in 1480, and terminate in 1597, but of the 117 years those of 69 only remain; as, however, the missing accounts occur in various places, those that remain may be considered as affording a very fair average. The total amount of receipts during the 69 years was £194 13s. 1¼d.; the payments, £116 19s. 7¾d.; leaving a balance in favour of the parish of £77 13s. 5½d., showing an average annual profit of £1 2s. 6d.

In these accounts, in almost every case, only the total amounts of sums received and paid are entered; but from the exceptions we can derive a little statistical information. Thus as to the amount of wages.

1526. Thomas Segur received for seven days' labour, at Bubhill works, 3s. 4d. John French received for his labour, at the same, 6d.; the last amount being for one day's labour.

1534. Carriage of the tin from Bubhill, two days, 8d.

1535. To two men for carrying tin from Bubhill, 8d.

1541. Paid for the carriage of tin from Bubhill, by one man and two horses, 1s. at Roodmas, and the same amount at Michaelmas.

1558. Paid to Brocke, for one day's work at Bubhill, 4d. The amount, therefore, paid for labour varied from 4d. to 6d. a day, the general amount being 4d.

Bishop Fleetwood, in his *Chronicon Preciosum*, states the amounts of wages of various artificers and labourers; the more skilled, as master carpenters, plumbers, &c., received, without diet, 6d. and 7d.; other labourers, from Easter to Michaelmas, 4d.; from Michaelmas to Easter, 3d. These

were the wages in 1514; therefore the amount paid at Chagford appears to have been at the general rate.

In Carew's Survey, as quoted in Delabeche's Geological Report (page 530), the measures used for black tin were "the gill," or pint, "the toplife," or pottel (which is probably the "tope," which will be shortly mentioned), "the dish," or gallon, and "the foot," or two gallons. "A foot" of black moor, or stream tin, was considered good if it weighed about 80 lbs., the same measure of mine tin about 52 lbs. The weight of, or measure contained in a "hull," I have not been able to discover. Neither am I certain as to that being the correct word, and am inclined to consider that it is an abbreviation. It appears to have contained about a gallon.

With respect to the value of tin; in 1520, (12 Henry VIII.) £3 16s. 8d. was received for two hulls and one toppe, and a tenth and half a tenth of a toppe of black tin. In 1542 St. Michael's wardens paid 2s. for six pounds and a quarter of tin (about 4d. per lb.), and 10d. for two pounds and a half of tin. (4d. a lb.) In 1568 a tope of tin, or half a gallon, was sold for 12s. 6d. (7½d. per lb.)

In 1580 (23 Elizabeth) £1 14s. 2d. was received for two gallons two pounds and a half (about 5d. per lb.), 14s. 8d. for a gallon and a quarter of a pound (nearly 3d. a pound), and 2s. 8d. for half a gallon, being nearly a penny three farthings a pound.

Thus the highest price was 7½d. a pound, and the lowest a penny three farthings; but the average appears to have been about 4d. a pound.

In this memoir no notice will be taken of the theories as to the age and manner of deposit of the beds on which the tin streamer works; the traces of his labour cover a wide field, and but little is known either as to the time when, or by whom the streaming was carried on. The object of this paper has been to give a contribution towards supplying that want.

These small and superficial workings, in their arrangements, present in some degrees a type of the mode of carrying on the more extensive mining speculations of the present day; the ownership was divided into transferable shares, the working was carried on from year to year with more or less success, the outlay not unfrequently exceeding the receipts. Probably Alice Balans (in 1530) had as great hopes of realizing a fortune from her 1-16th share in the apparently unprofitable works at Lagland, as those now have whose names appear in the "cost book" of many a Wheal St. *Blank* of the present day.

ST. MICHAEL'S, BRENT TOR.

BY JAMES HINE, F.I.B.A.

BRENT TOR, four miles north of Tavistock, "a high rocky place," says Risdon, in his *Survey of Devon*,—written two centuries and a-half ago—"on the top whereof stands a church, full bleak and weather beaten, all alone, as it were forsaken, whose churchyard doth hardly afford depth of earth to bury the dead; yet, doubtless, they rest there as secure as in sumptuous St. Peter's until the day of doom.

"This tor serveth as a mark to sailors who bear with Plymouth haven, which, with Tavistock, whereunto it belongeth, and Milton, maketh a hundred. All which lands, at the suppression of the abbies, were given to the Lord Russell, Lord Privy Seal, and afterwards Earl of Bedford, ancestor of the present Earl of Bedford and Lord Lieutenant of this county, who was sent down into Devonshire as Lord President."

There are numerous instances of towers serving the purposes of beacons and watch towers, as well as belfries. The late Dr. Petrie, and other antiquaries, have clearly proved that the Round Towers of Ireland were intended for these as well as other uses. In that part of Warwickshire known as the Forest of Arden, the ancient spire of Astley Church was the guide of the district, and called the "Lantern of Arden." In the octagonal lantern built over the tower of All Saints' Pavement, York, a large lamp was formerly suspended, which served at night as a beacon to travellers over the extensive forest around. But more commonly the beacon fires were lighted in an iron framework set on the top of an angle turret. There is a turret of this description on St. Michael's Mount, in Cornwall, and at Hadleigh, in Essex, where not only the turret remains, but the iron grate in which the fires were lighted. To mention only one other distant example—Dundry Tower, in Somersetshire, one of the loftiest and best proportioned in that county of noble towers, though attached to a very insignificant church, is built on the crown of a steep

hill, and is visible far down the Bristol channel. It was erected by the merchant adventurers of Bristol, in the 15th century, as a landmark for seamen, and is remarkable not only as a beacon, but for the beauty of its design and the boldness of its proportions.

One of the most ancient edifices of this class in England is the subject of this short paper, the little beacon church on Brent Tor, which, whether we regard its antiquity, use, or situation, is altogether a curious structure.

Brent Tor, or *Bren*, as it is still sometimes called in the locality (from the Saxon word *Brennen*, to burn), in the British period was no doubt a beacon on which wood turf and other fuel was burnt by way of signal. There was probably a line of beacons on the Dartmoor tors, and the intelligence of invasion or distress would be communicated by a rapid succession of beacon fires. The present edifice, erected in the 13th century, but perpetuated and emphasised the purpose to which the hill had been devoted from a remote time. It was the church's consecration of the Tor as a "famous sea mark," and not unlikely (though opposed to the common tradition) the building was erected by the abbots of Tavistock, to whom the lands belonged, who, in this, as in other ways, would be likely to turn their piety to practical account.

Most of the church is contemporaneous with the earliest existing remains of the abbey, with those very beautiful portions of an Early English arcade and arch in the Tavistock churchyard. Tradition says, but the story is not very ingenious, that the foundations of the little church were at first laid at the foot of the mount in a position more convenient for church goers; but that the devil, of whose personality and active interference in ecclesiastical matters there were so many ocular proofs in the middle ages, removed the stones by night from the base to the top, from no preference, it is presumed, to the loftier site, but with the intention of frustrating the project altogether. In this he was disappointed; for the builders continued their labours at the summit, though often harassed by furious winds and the visits of the arch enemy. On its completion, however, and immediately after its dedication to St. Michael, the patron saint hurled upon the devil such a tremendous mass of rock, that he beat a hasty retreat, and never again ventured near the sacred building; so that the beacon lights which were afterwards set up on the top of the tower were never once extinguished by the prince of darkness.

An inscription on the south wall, which is referred to in

most notices of the church (but now I believe concealed by plaster), has probably served to keep alive a tradition not yet altogether discredited, it is said, by some natives of the moor:—"*On this rock I will build my church, and the gates of hell shall not prevail against it.*"

But as there is no smoke without some fire, so probably there are few traditions which have not a shew of verity on which to rest, especially of an age when all truth was expressed by symbols and legends, when all ideas of good were centred in the guardian angel, and of evil in the devil; when the spirit divine was diffused

"Through forms of human art,"

and when, as Coleridge expresses it, the material church itself became the petrifaction of religion.

The real incidents connected with the erection of a church on this rugged and desolate peak—the opposition not only of the elements, but of the wild and heathenish inhabitants of the neighbourhood, would afford sufficient material for the imaginative, though not necessarily superstitious, monk of Tavistock—the novelist of the age—out of which to weave this romantic story, with a moral at its close.

Fuller, in his *English Worthies*, describes the inhabitants of an adjoining village, called the Gubbins, as a "lawless Scythian sort of people," a wild and well nigh savage race in *his* time. It may be presumed that they were in a still more barbarous state three centuries previously; and I venture to suggest that the Gubbins were the evil disposed and evil possessed spirits who, from a strong aversion to the inroads of civilization, endeavoured to pull down this church (probably the first erected on the moor) as fast as it was being built up, and who, on the day of consecration, when the priest first said mass, and the psalm of praise was first chanted on the tor, became alarmed at the moral force arrayed against them, and *fled*. There is also another tradition which ascribes the erection of the church to a merchant who, overtaken by a great storm at sea, vowed that if he escaped in safety he would build a church upon the first point of land which should appear in sight. This happened to be Brent Tor, and here accordingly he fulfilled his vow, in a manner, it must be admitted, consistent with the utmost economy, the church being exceedingly plain, and as small as it well could be. In extenuation, however of the merchant's apparent niggardliness, it may be said that an ornate structure would have been out of place in such a position (except that the gods see

everywhere—an æsthetic consideration, not much regarded, I fear, by those who have to count the cost), and the present edifice has always been found sufficiently commodious for those who have been anxious to attend service therein.

The building consists of a nave 37 ft. 6 in. long, and 14 ft. 9 in. in width, with a tower open to it about 8 ft. square, and a porch on the north side. There is no developed chancel, but the floor at the eastern portion of the church is raised one step, and at a distance of between 10 and 11 feet from the east wall there was probably in the middle ages a low stone screen.

There is a narrow doorway on the south as well as on the north side, and the church is lighted by two small Early English lancet windows, only 7 inches wide, and a modern window at the east end, of an altogther incongruous description.

Most writers, in speaking of this church, and referring to old records, state that there was a church on this tor as early as 1283, and suggest that a second edifice was afterwards erected. From a careful examination of the building, I am satisfied that the present, with some few later insertions, is the original church, and that it even dates back probably half a century earlier than the year alluded to as of the first church. The general character of the masonry, as I have said before, is Early English. The small lights, the doorways, and the battlemented parapet which surrounds the church, undoubtedly belong to that era of church architecture. The walls of the church, it is hardly necessary to say (as they have stood so long), are sufficiently substantial, being generally 3 feet in thickness. The masonry is of dark brown stone, apparently ironstone, what are technically called the dressings being of the green slate stone from the neighbourhood of this town: and it is interesting to see in this latter stonework how the beautiful though simple lines and curves of the Early English style have been adopted even in this lonely and unfrequented little church. If, in this 19th century, we built a church on a tor (an unlikely thing, I admit), we should probably employ our roughest hands, thinking that anything would do in such a situation, begrudging a moulding or a leaf; but the monks of Tavistock, whilst no doubt they employed the moor men for the plain masonry, yet reserved some *few* portions for the tender and delicate handling of the skilled workmen, and thus shewed as well their piety as their taste.

Granite has not been used in the building, nor, I believe,

does the tor contain it. Polwhele, in his *Devon*, says, "Brent Tor, and several other tors on the west side of the river, are undoubtedly volcanic. Brent Tor is very curious; it being one mass of hill, rising to a great height from a perfect plane, and entirely divested of every thing of the kind besides itself, and differing from all other tors which we visited. We found it covered, between the rocks, with a fine verdure, and every indication of a very rich soil, far different from the heath which surrounds it. We brought away some bits of the rock, which in general is a deep rusty blue, inclining to black, hard and heavy, with pores here and there as if worm-eaten; some of the pores contain a little of a brownish red earth, but whether of the ochre kind we could not determine. Near the top of the tor some pieces were found more porous, even resembling a cinder, or piece of burnt bread, and very light. Another observation was very striking, that this tor does not contain a single particle of granite that we could discover. In this it differs from most of the other tors we visited, though we found some on the west side of the river Lid, which contained stones of a similar porosity. From the above observations, we were led to believe that this remarkable tor was the effect or remains of some long-ago extinguished volcano; as, in its appearance, situation, soil, strata, &c., it argues strongly for it."

An idea has been very generally entertained, that in digging burial places at this spot the rock is found to be so saturated with moisture that the excavation is in a short time filled with water. The fact is, however, the ground is as dry here as in other churchyards; and the notion doubtless originated in an incident which is said to have occurred after a heavy fall of rain, when, a coffin having been brought for interment, the grave was found partly filled with water, which had been directed into it by the shute from the roof of the church. There is, however, no lack of water on the hill; as on its eastern side a spring gushes forth which has never been known to fail.

The little church is only between 10 and 11 feet high from the floor to the ridge, and has a massive and moulded oak roof covered with heavy lead, the inclination of the timbers from the walls to the ridge being about 12 inches. The tower is about 40 feet high, and, like the rest of the building, very plain, and has three small lights, one of which was an insertion of the 15th century. Suspended from the side, or on the top, it is more than probable that a fire grill was formerly placed.

There is a single bell which I was unable to get at, but on it is said to be the inscription "*Gallus vocor ego, solus per omne sono.*"

There are no monuments, and indeed scarcely any epitaphs, so that the old English proverb, "He lies like an epitaph," is not verified here. There is, however, one rude inscription, which may be deemed worthy of notice; "Heare under this stone lieth the bodie of John Cole, jun., of Litton, who departed this life the 23rd of November, 1694, æta: 22. Also Johan, his sister, who was buried the 1st of February, 1694, æta: 11!

"If thou be serious (friend) peruse this stone;
If thou be not soe, pray, let it alone.
Against death's poison, vertue's the best art;
When good men seem to die, they but depart.
Live well: then at the last with us thou 'lt feele
Bare dying makes not death, but dying ill!"

At the western end of the church, in its original position near the north porch, is an ancient octagonal font, without carving and very plain, but in a good state of preservation.

This, then, concludes my brief account of the little church of St. Michael's, Brent Tor, which for 600 years has stood on this singular peak, "all alone, as if forsaken," but which has fulfilled for this long period its office of mercy as a landmark for sailors.

It is interesting to know that England, in her earliest, as in her latest history, has had her beacon towers and lighthouses for the tempest-tossed mariners of all nations; that

. . . . . . "That pale and white faced shore
Whose foot spurns back the ocean's roaring tides,
And coops from other lands her islanders;
. . . . . that England, hedged in with the main,
That water-walled bulwark, still secure
And confident from foreign purposes,"

has presented on the highest peaks, and on the most desolate parts of her coast, these proofs of her civilization, these unerring symbols of her people's humanity.

ARCHÆOLOGICAL NOTES OF TAVISTOCK AND NEIGHBOURHOOD.

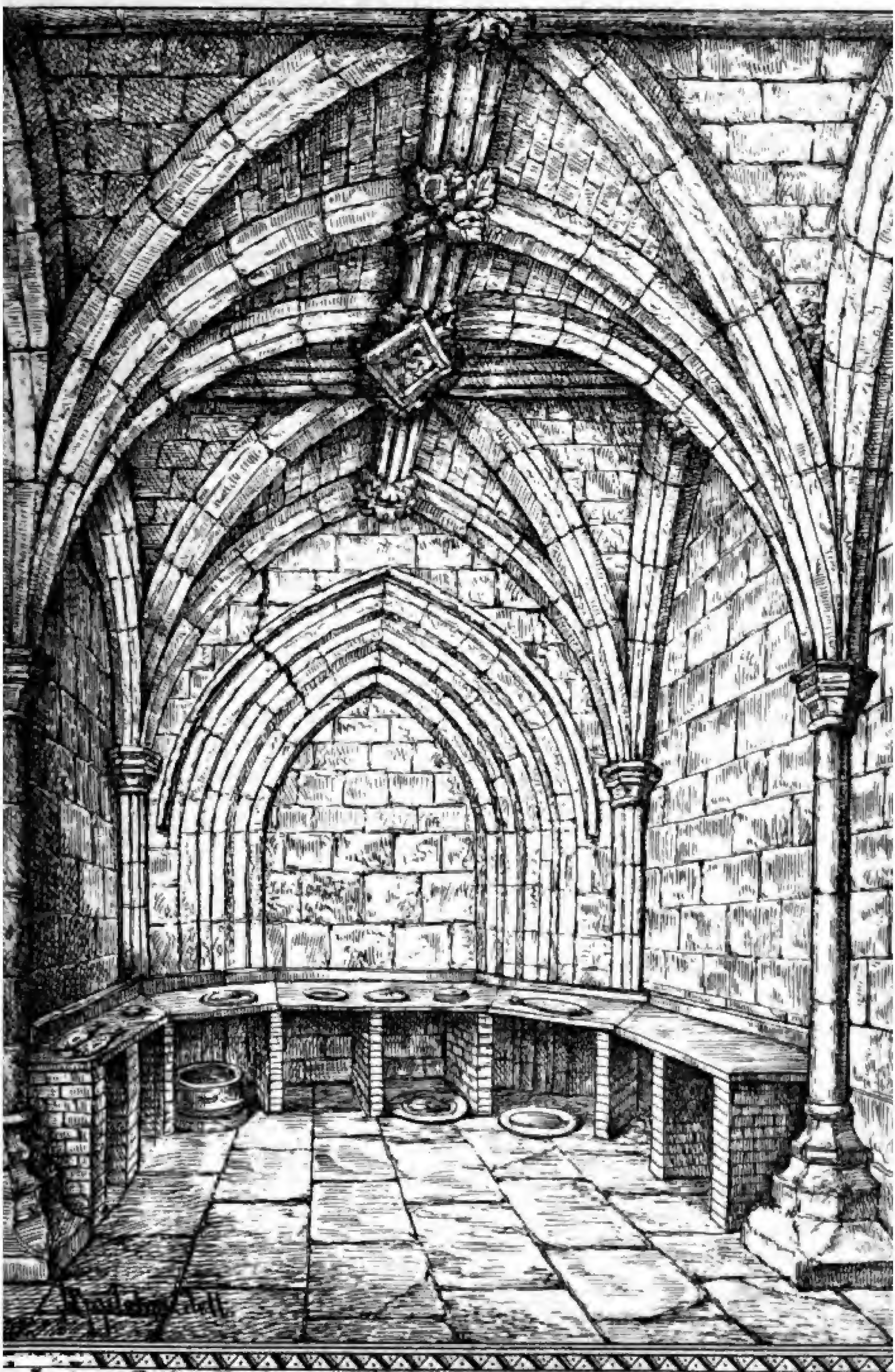
BY R. APPLETON, F.I.B.A.

IN the good old times, long gone by, Tavistock appears to have been a place of very great importance; for we find its historians referring to it as a place of "*note and fame second only to Exeter*" in point of size and architectural grandeur, especially in the time of King Edgar. Its history dates back to a very remote period, as will be seen by the following notes collected from various sources and authorities. The first account we have of it is that in or about the year A.D. 961, a monastery was founded by one Ordulph, son of Orgar or Orgarius, called also by Polydore, Hordogarius, who was a Duke of Devonshire, and kept his court at Tavistock. The monastery is said to have been dedicated to the blessed Virgin and St. Burien, and by others to the Virgin and St. Rumonus; at any rate St. Rumonus was one of its bishops, who was translated from Ireland and was buried at Tavistock and canonized. The monastery was completed about the year 981. It appears that Ordulphus was instigated to form the monastery by a vision, in which he was commanded to build an oratory, and that his wife was guided by an angel to a beautiful spot for the site; and it was here Ordulph erected his abbey, (even on a grander scale than directed, making it large enough for 1000 men, to which were added other houses for the services of the Monks,) and richly endowed it. Returning to Ordulph, the founder of the monastery, history states him to have been a man of amazing strength and size, and that he once exercised his powers upon the gates of Exeter to the discomfiture of its inhabitants. This Ordulph was the brother of the celebrated beauty Elfrida, who became the second wife of King Edgar. For the sake of the ladies of my audience, I must not fail to mention a story or legend, doubtless to a great extent true, to show the folly of the fair sex, and the treachery of the unfair sex. Elfrida, as before mentioned, was the sister of Ordulph, and only daughter of

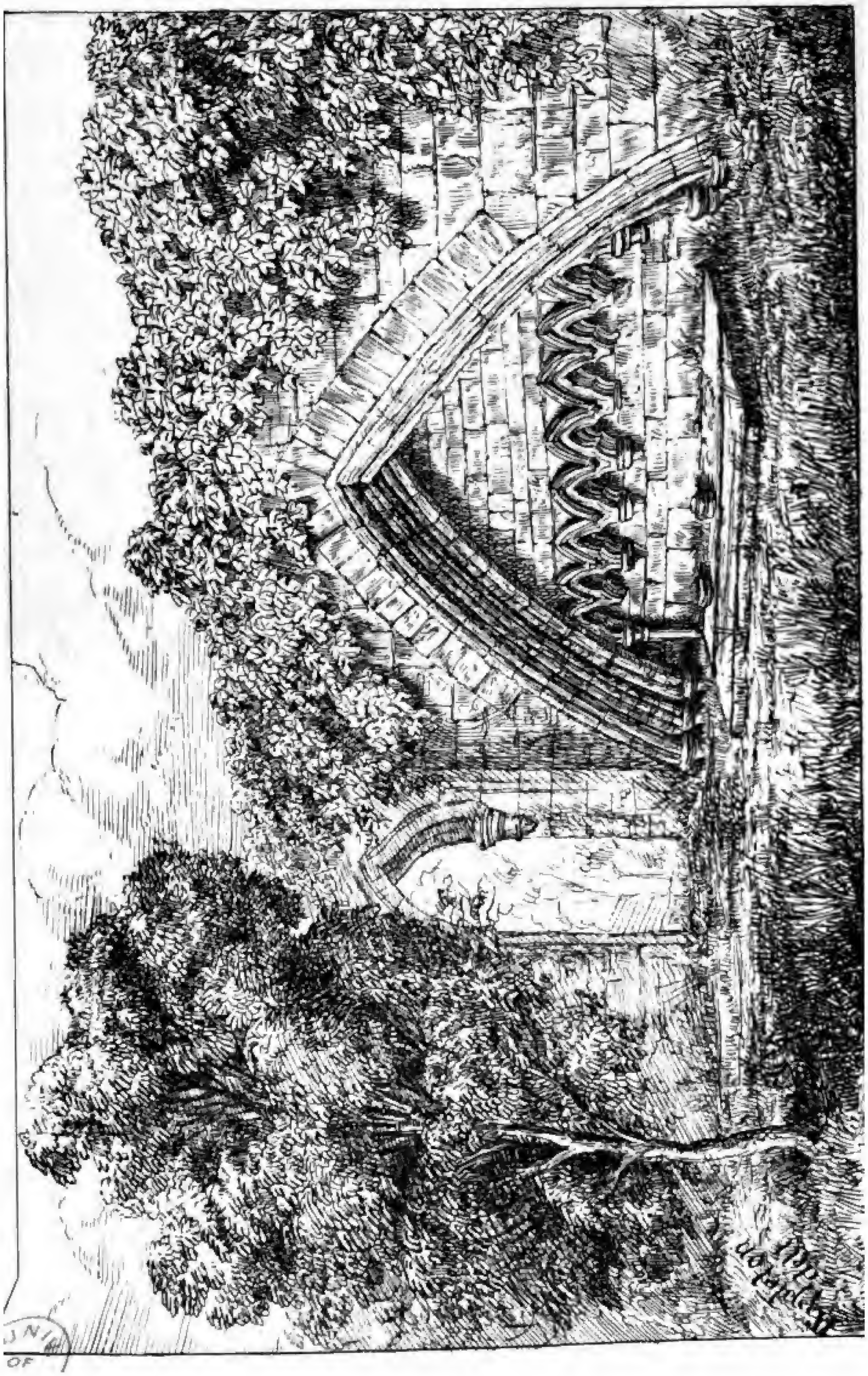
Orgdar. She is said to have been possessed of surpassing beauty, or, as our historian has it, "she was the paragon of her sex and the wonder of nature." It is therefore not surprising that her charms were talked of far and near. King Edgar, hearing so much of her, sent one of his nobles, Ethelwold, Earl of East Anglia, to see this pearl, with instructions that if the report of her were true he was to seize her for the king. Ethelwold was so much struck with the beauty of the young lady, that instead of performing the duty assigned to him by the king, he determined to appropriate her to himself; and to accomplish this disparaged her to the king, informing him that there was nothing very particular about the lady, and that there were many others at the court much superior to her, whereupon Edgar for the time thought no more about her, and she became the wife of Ethelwold. Still, however, fresh reports reached the king of the surpassing beauty of Elfrida, and he resolved to go and see for himself, which he did under the excuse of going on a hunting expedition at Exeter, where once arrived he started off for Tavistock. Ethelwold hearing of the king's approach, and knowing his weakness when ladies were in the question, thinks it necessary to put his wife upon her guard, and lectures her upon the virtue of discretion, advising her to conceal her charms and veil her beauty, the king being not over scrupulous as to the number of his wives, if he took a fancy to any fair damsel. Elfrida, however, in the vanity of her sex resolves to act very differently, and upon the king's arrival at her lord's mansion, which he honours with a visit, presents herself in all the attractions of superb dress, to add its power to her own irresistible fascination. The next day Ethelwold was killed while hunting, accidently say some, others that the king knew all about it. At any rate, Elfrida thereupon became a queen, and was, as history informs us, the mother of the princes Edmund and Ethelred. The former did not live long, and Ethelred became king in 978, after the death of his half-brother Edward surnamed the martyr, who was the son of Edgar by his first wife Elfleda. Ethelred seemed to have been a great benefactor to the monastery of Tavistock, for we are informed that he not only confirmed all the acts of his uncle in 991, but granted many additional privileges. The monastery was occupied by Augustine Friars (some say Benedictine). From this time the kings of England claimed the honour and exercised the right of founders and patrons of Tavistock Abbey. King Edgar died in 975. The monastery founded by Ordulph, or Orgdar, scarcely stood thirty

years, for it was destroyed by the Danes in 997, during one of their invasions to this part of the country; but it was speedily rebuilt with greater grandeur and magnificence on an enlarged scale, and its extent may be judged of to this day from the ruins still existing. This abbey after its restoration was consecrated by the Bishop of Crediton in 1032, and is said to have "eclipsed every religious house in Devonshire in the extent, convenience, and magnificence of its buildings." The chapel adjoining the Bedford Hotel is said to have been erected on the site of the abbey refectory, but this is very doubtful.* Under the reign of King Canute, and the zeal and influence of its second Abbot Livingus, the monastery greatly flourished. Livingus was created Bishop of Crediton, and St. Germans was united to his see. He died in 1046, and was buried in Tavistock abbey; he was succeeded by Eldred, who crowned William the Conqueror. There appears to have been a chapter house of some importance, for in the history of the Abbots we find John Chubb was deposed for his extravagance, neglect of discipline, and abuse of power, *in the chapter house* of Tavistock. Also in Leland's Collectanea we read of the circular *chapter house* with its forty-six arches and thirty-six niches or seats, let into the walls and surrounded with curious sculptures. Orgar's bones are said to have been deposited in the cloisters. There was also a school called the Saxon school, which was pulled down in 1736. Buckland Abbey, belonging to the Cistercians, founded by Amicia 1278, formed part of the monastery; it afterwards became the seat of Sir Francis Drake. Dunterton, Milton Abbot, and Brentor, also belonged to the monastery. Robert Champeau, otherwise Campbell, was Abbot in 1285, and is highly commended for his piety and zeal; during his government several parts of the abbey were rebuilt, particularly the conventual church of St. Mary and St. Rumon, which is said to have been 126 paces long, exclusive of the Ladye Chapel. It is perhaps a portion of this Abbot's work which still remains on the south side of the present parish church, erroneously stated to be the grave of Ordulph, unless erected as a monument to his memory some 300 years after his time, the architecture plainly proving that it was not erected at the period of his death. This small vestige of the earlier buildings of the abbey, measuring only a few feet, is

* The accompanying illustration shews the *porch* of the *reputed* refectory, but it is far more probable that a *chapel* always stood here. Over the porch is a parvise with a very good timber roof.



Larder at Bedford Hotel, commonly called entrance to Refectory of Abbey



all that remains to tell us of a stately edifice in the prevalent style of the thirteenth century, (little inferior perhaps to Wells, Exeter, or Glastonbury,) which once stood on this spot; the rest of the conventual remains are of a much later date. (See illustration.) Many portions of the older buildings may be detected built into the walls of the existing ruins, and some beautiful details can be seen in the vicarage garden, which also contains many other very interesting remains.

Bishop Stapledon dedicated this noble church and two altars in the nave, August 21, 1318; it was taken down in 1670. In it had been buried the founders and (according to Rudborne) Edwin, brother of king Edmund Ironside, and many other illustrious persons in their generations. On May 21st, the same year, the Bishop dedicated the parish church of St. Eustachius at Tavistock, which adjoined the Abbey enclosure. There appears to have been a leper house in existence about the year 1374, for we find a note that on the 26th September, in that year, Bishop Brantyngham granted an indulgence of 20 days to all persons in the Diocese of Exeter who should contribute to the support of the leper house. In 1380 Thomas Cullying was Abbot, and is stated to have finished the tower begun by his predecessor. The house lately pulled down near the new church is said to have been a portion of the leper house. Bishop Brantyngham, on 7th July, 1391, licensed to this Abbot a chapel within his house at Morwell, built by him. About the year 1462, Cowick Priory was granted to the Abbey by Edward IV. The Abbey of Tavistock had many noble benefactors, among whom are numbered Ferrers, Fitzbernard, Edgcombe, and many others. By favour of Henry VIII. the Abbot was honoured with a mitre, and made a peer of the realm by the title of Baron Hurdwick; Hurdwick is about a mile from Tavistock. Till the suppression of Tavistock Abbey, Werrington continued its principal manor. On the 20th March, 1539, the Abbot (probably John Peryn), with twenty of his brethren, surrendered his monastery, and received for so doing a pension of £100 a year; and on July 4th, in the same year, Henry VIII. granted the site of the Abbey and the principal part of its estates, together with the borough and town of Tavistock, the rectory and advowson of the vicarage, to John, Lord Russell, afterwards created Earl of Bedford. After the suppression of the Abbey, a chapel was formed within its enclosure, and was licensed by Bishop Veysey, March 10th, 1540, for the celebration of divine service. The last Abbot's will, dated October, 1549, at Tavistock, was

proved in the Prerogative Court, April 30th, 1550, and it is believed the Abbot was buried in the parish church of Tavistock. The Convent of Tavistock may undoubtedly challenge the honour of possessing the first printing press in Devonshire and Cornwall; for we find this note, "Walton's translation in English metre of 'Boetius de Consolatione,' emprinted in the exempt monastary of Tavistoke in Denshyre, by one Thomas Rychard, Monke of the said monastary, 1525, 4to;" and "The Confirmation of the Tynners' Charter, 26 Henry VIII., in 16 leaves 4to." Copies of some of the works then printed are still preserved in Exeter College, Oxford.

At the west end of the town stands an old gateway which formed part of the residence of the Fitz family, and said to have been the spot on which a duel was fought between Sir John Fitz and Sir Nicholas Slanning, in which the latter was killed. In the church there is a monument to Sir John Fitz, of Fitzford, and Gertrude his wife, daughter of Sir William Courtenay, of Powderham, said to have been erected by Mary, only child of Sir J. Fitz. Some of the Fitz family married with the Glanvilles and Percys. There is also a monument representing Judge Glanville and his wife, with their seven children. Prince also mentions an honorary monument to Queen Elizabeth, now gone. The Bear Inn, at Exeter, was the Abbot's town house; the last Abbot leased it for a term of sixty years, from November 7th, 1538, to Edward Brygeman. In 1701, when Prince published his Worthies of Devon, were to be seen the arms of Ordulf the founder of Tavistock Abbey, on painted glass, in the great window of the dining room, also the arms of Brygeman. The principal remains of the ancient buildings now to be seen are: First, the beautiful altar-tomb in the churchyard. Second, a gateway in the vicarage grounds, probably belonging to the Abbot's hall. Third, the still house, and Betsy Grimbal's tower (who is said to have been a nun, and was murdered there). In the neighbourhood we have Walreddon house, erected in the reign of Edward VI., and partially destroyed in the civil wars. It once belonged to Lady Howard, who was the heiress of Sir John Fitz, and married four times, her last husband being Sir Richard Glanville, governor of Lydford castle. Crowndale Farm, the birthplace of Sir Francis Drake, is also an object of interest in the neighbourhood. An interesting building is to be seen at Tiddebrook, said to be the monastery hospital. Holwell, for many years the residence of the Glanvilles, prior to their residence at Kilworthy, was a house of much pretensions, erected in the 16th century. Sir John, son of Judge Glan-

ville, was speaker in the House of Commons in the reign of Charles I. Time will not permit us to say much of Lydford, one of the earliest towns in Britain, erected by Julius Cæsar, B.C. 54, and once possessing a mint for tin pennies. Domesday book calls it a *walled town*. Assizes were held alternately here and at Exeter. The castle dates as far back as the middle of the 13th century, and was aftewards given by Edward II. to Piers de Gaveston, in 1307. Nothing now remains but the "Keep." Judge Jeffries presided as judge at Lydford castle.

AN ATTEMPT TO APPROXIMATE THE DATE OF THE FLINT FLAKES OF DEVON AND CORNWALL.

BY C. SPENCE BATE, F.R.S., F.L.S.,
Corresponding Member of the Zoological Society, &c.

THE large number of flakes and broken fragments of flint that have been found scattered over the surface of the country, has attracted considerable attention from archæologists.

In the neighbourhood where flint is abundant, the circumstance does not strike the observer so forcibly as in localities where, geologically, flint does not exist. Throughout the counties of Devon and Cornwall flint flakes and chips are broadly scattered. In some localities, such as the neighbourhoods of Barnstaple and the Lizard, they are abundant, whereas in other places they are only found as isolated specimens.

The character and appearance of these flaked specimens are various, some being well-formed arrow heads, others representing the block from which the flakes were struck, and other fragments of most irregular shape. These latter are more common in districts where the flint flakes are most abundant; but in those regions where they are scarce, the few specimens found generally represent well formed flake implements.

It is several years since it was first reported by Mr. Whitley, that flint flakes of this description were to be found abundantly distributed at Baggy Point, on the north of Devon, as well as along the coast line. They have since been observed by him several miles inland, on the banks of the Taw; and they are also scattered over the waste lands that surround Dosmare Pool, where they were found by Mr. Hext in some quantity, and recently by Mr. Whitley; they have been found in abundance on the waste as well as cultivated lands of the Lizard district, and as far west as the Scilly Islands by Mr. Augustus Smith. In sparser numbers

specimens have been taken on the borders of Dartmoor,* and by Mr. Pengelly in the neighbourhood of Brixham; and occasionally in tumuli throughout the counties of Devon and Cornwall.

The assertion by archæologists that these flint flakes are the result of human labour, either, as in the more perfectly adapted forms of design, or as the waste material left in the efforts to produce those forms, has given an interest and importance to the discovery of these flakes, in the hope that their more extended study may throw some light on their history, as well as on the period at which they were made.

Near the village of Croyde, at a place called Baggy Point, the flint flakes appear to be abundantly spread over the face of the hills; but towards the sea-shore, at the entrance to a little vale, through which a small stream of fresh water runs, these flints appear to have collected in larger quantities. The place in which they are found is evidently the accumulation of the superficial soil of the hill, having been gradually brought into the valley, and probably with it some of the flakes; but if so, they could not have been borne from far, as there is not the slightest evidence of wear, or rolling of the flints, circumstances that must have occurred had they been water-borne for any great distance. These flints have been found with other stones, and evidences of the most primitive kind of human industry. These mostly exist in the form of rolled-stones from the sea-beach, some of which show evidence of having been used as hammers, and others as whet-stones; with these have been found some portions of pottery of very coarse structure, as also several specimens of flint flakes, that evidently have been under the action of fire, together with small traces of charcoal, and a piece of a long bone—probably human. These severally having been collected together, afford presumptive evidence that the spot on which they were found was in the neighbourhood where a colony of the ancient people sojourned, the exact site of which has yet to be determined. Similar flints to those that lie buried here

* Since the reading of this paper, we are indebted to Mr. Aborn, of the Government Establishment at Prince Town, for numerous flint-flakes that he obtained from the prisoners, who found them during their labours for the draining of the soil, under four feet of peat, and two more that had previously been received. These were all on the soil beneath the peat, inclusive of an exquisitely wrought barbed arrow-head, excepting one, beautifully worked on both sides, leaf-shape specimen.

may be found in tolerable numbers on the adjoining hill, where the plough has never been, but where the soil has been washed away from the surface of the rock; these are to be found, but more sparsely, on the opposite hill, and along the coast toward and beyond Croyde Bay.

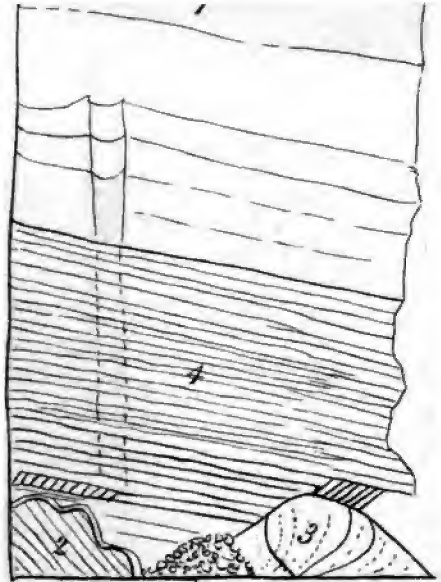
The soil in the chief place of excavation is about eight or ten feet above the slate rocks of the country. The lower portion of the bed consists of a yellowish clay, and the upper part of surface soil washed down from the adjoining hill; a few inches above the clay a line of black mould exists, and it was in and above this line that all the flints and materials were found, that is, within four feet of the surface.

Along the coast, from Baggy Point to Braunton Burrows, a belt of sandy rock exists; soft in its structure towards the upper part, but hard as granite in the lower beds; this belt of sand has been pronounced to be a raised sea beach by Sir Rod. Murchinson and Professor Sedgwick, who state it to be one of the finest specimens of the kind. Over this so-called raised beach the surface soil has accumulated, and in this soil some flint flakes were found. Passing onward, we come to a tract of two or more miles of blown sand, which is separated by a broad and navigable river from a low grassy plane (fig. *C* 1), that stands at a level with high spring tides, and which is separated from the sea by a broad ridge of large pebbles, that rise to the height of about sixteen or twenty feet. Outside this pebble ridge, an extensive beach of fine sand covers the surface, as far as low water mark at ordinary tides; beneath the sand, and which at different spots may be seen peeping through, is a bed of blue clay, about six feet thick (fig. *C* 2); beneath which is a layer of pebble boulders (fig. *C* 3), below which exists the angular fragments formed by the disintegration of the slate rock (fig. *C* 4).

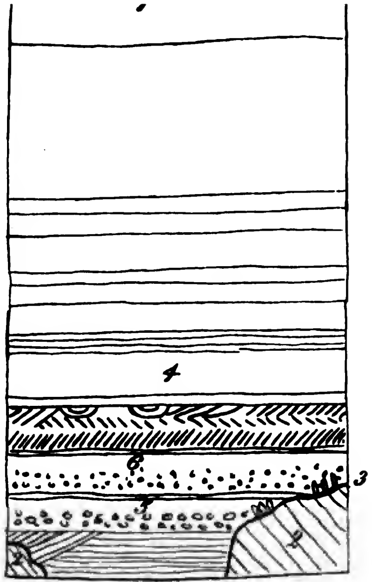
In the bed of clay beneath the sand, the roots and trunks of trees testify to the former presence of vegetable growth, of which the kinds may be interpreted by the presence of acorns and nuts found in the clay; and the strength and luxuriance of the trees may be supposed from the quantity of the fruit, the size of the remains both of the roots and the trunks, as well as from the circumstance that the perforations of the nuts show that squirrels skipped among the branches of the trees that grew here.

In this clay, in which roots, nuts, and acorns exist, flakes of flint are not uncommon, and some have been found which bear the impress of having been under the action of fire.

Thus we see, in this place, the flints exist in connection



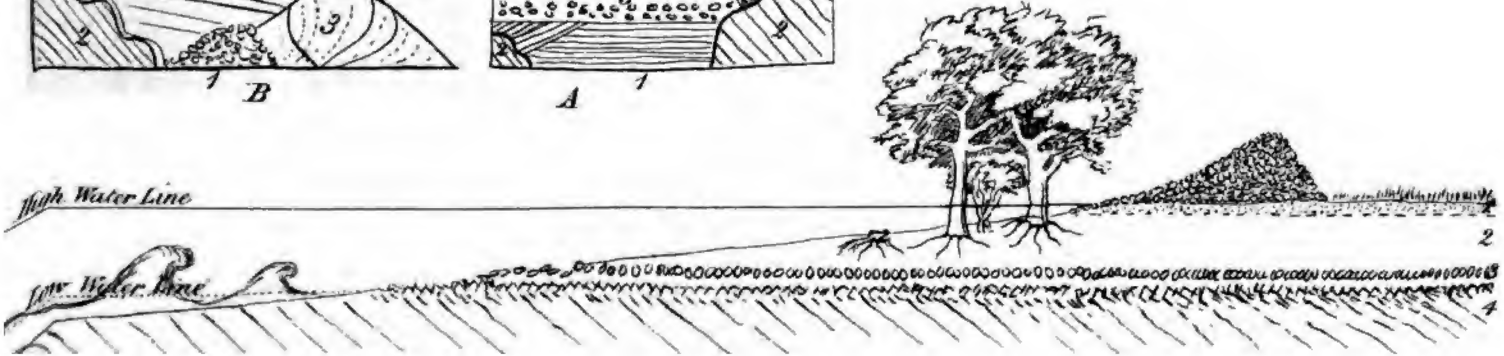
B



A

D

E



with a submerged forest, whereas at Croyde, about four miles to the eastward, they are found in soil overlying a deposit that has been, by our ablest geologists, pronounced to be a raised sea beach.

It appears to me, therefore, that by a careful study of the geological history of these different formations with which the flints are in connection, an approximation to the period at which the flints were deposited may be arrived at.

The first important study will be the careful analytical examination of the so-called raised sea beach.

It extends for more than two miles along the coast, and rises from the present sea beach to the height of about fifty feet. It consists of fine sand, mixed with a few shells and pebbles towards the lower portion. The general aspect being a series of horizontal layers, a nearer inspection shews that these horizontal layers are built up by numerous thin stratas, exhibiting lines of false bedding in various directions. In the upper layers the stone is soft and friable, in the lower it is hard and firmly cemented together, so that it is not easily broken by the geologist's hammer. In the upper layers the sand is generally free from extraneous objects, but towards the bottom a few shells and numerous pebbles of different kinds are found; the shells, as far as my own experience goes, and I believe also that of Mr. Whitley, who accompanied me, consist invariably of single and dead valves of (*Mytilus edulis*) the common mussel; to which may be added, on the authority of Professor Sedgwick and Sir Roderick Murchison, those of *Cardiun edulis, Patella vulgaris, Solen,* and *Donax truncalus,* of which list the last two species, as well as *Cardiun edulis,* can live where sand exists; and probably these, as we observed of *Mytilus,* are but dead valves. The pebbles are found in the lower stratifications, the largest specimens lying in the lowest, while a little higher smaller specimens exist. These, as far as our observations went, consisted of rolled fragments of granite, quartz, trap, basalt, and flints; in fact, of materials very similar to those which exist near the high water mark of the present beach, and which are obtained probably from the breaking up of this so-called raised beach, which overhangs it here. In one place, resting on the present beach, supporting the ancient, is a large boulder mass of granite, estimated to weigh about twelve tons (fig. *A* 1); the upper portion, that is, all that can be seen, is smooth, and rounded in a manner that suggests that the whole of it is similarly worn, a circumstance that corroborates the opinion of Mr. Williams, in his paper, which forms a supple-

ment to that of Sir R. Murchison and Prof. Sedgwick, that it has been borne from afar, probably by an iceberg in the great glacial epoch. The granite contains red felspar, and is said not to resemble Dartmoor or Lundy granite. But I have recently been informed by Dr. Trefry, that every kind of granite is found in his quarries in Cornwall; and I have seen in his porphery hall, at Place House, Fowey, specimens very similar to that of the boulder in Barnstaple Bay; therefore we need not go so far as Aberdeen, as supposed by Mr. Williams. But still, we cannot but suppose that some great transporting power must have been required to bring this granite mass even from the nearest granite district to where it rests. Not being a geologist, I cannot pronounce the epoch to which this boulder belongs; but of this there can be no doubt, that it was lodged in its present position before the deposit that we call the raised beach commenced. The elevation of the highest point of the raised beach is about forty feet, we must therefore suppose that the highest point must have been covered with water, at least, at high tide, before the elevation of the mass commenced. Forty or fifty feet being the greatest depth of the structure, it must necessary follow, that the lowest portions of the stratification must have been from three to four fathoms below the level of the lowest tides. Now if we examine the so-called raised beach, where it rests upon the slate rocks of the present beach, we find that specimens of *Balanus balanoides* remain in abundance attached to the rocks (fig. *A* 3), a certain proof that they were living in the position in which they were found before the sand that forms the raised beach was deposited, the deposition of which probably killed them. Therefore, when the sand was first thrown on them, they must have been several fathoms under water. But we know that the species of *Balanus* that we find here cannot live in such a position; that its normal habitat is a belt on our rocks, between half tide and high water; it is therefore evident, that the present beach must have been at or near its present level when the *Balani* that we found below the so-called *raised sea beach* were living; that is, that they were in the same position as they are now, with respect to the land and sea, when the sand was first deposited on them; consequently, no evidence that any elevation of the coast line has taken place since the so-called raised beach has been found.

To shew what a thing is not, may be easy; to shew what it is, may not be so. The evidence in the latter case may not be so conclusive as in the former; but still, that which

exists appears to be tolerably demonstrative. The lowest stratification alone contains pebbles, and these are all rolled and worn, and such as will be frequently found belting a sandy shore at and above high water wash; above these lines of pebbles the structure of the beds is that of finely comminuted sand, without admixture of foreign bodies. A stray valve of mussel, and according to Professor Sedgwick, of limpet and cockle, may occasionally be met with; but these our experience has shown to be dead valves, a fact that is proved from the concave side of the shell being invariably downwards, as well as the specimens of the bivalve species being solitary. The stratification of the beds is such as corresponds with no sedimentary deposit, the false bedding is persistent in any part, and takes peculiar forms, sometimes those of semi-circles (fig. *A* 4), and short oblique lines, assimilating to lines of cleavage. The upper portions of the beds are soft and friable, the lower is hard and petrous; occasioned, I believe, by the action of the sea-water decomposing a portion of the calcareous material, and cementing the whole into a solid mass. And the entire structure conduces to the conviction that the so-called raised beach is, in reality, the undestroyed remnant of an extensive district of wind-borne sand, similar to that which now exists at Braunton Burrows, that formerly extended from that place to Baggy Point, and reaching some way out towards the sea; of this latter hypothesis we have evidence in the portions remaining, hardened into firm stone, that still exist, capping the summits of the rocks on the beach to the extent of some two hundred yards seaward. Moreover, a study of the stratification of the hills of drifted sand demonstrates a series of layers that assimilate to the various modes of stratification found in the ancient bed, and which, I think, can be accounted for by no other means than the varying and ever-changing direction of the wind, that builds, destroys, and restores again, still ever adding to the heap.

This, I think, will demonstrate, since the flints are in the soil that surmounts the ancient sandbed, and as this ancient bed has been deposited since the present beach has been at its present level, that the flints are more recent than the most recent elevation of land upon that coast.

But the question now arises, whether or not, since the flints have been found in the submerged forest at Northam Burrows, they may have been deposited prior to the latest depression of the land upon that coast? To determine this point, it will be necessary to analyse carefully the geological conditions of

the deposits that exist in connection with the flint flakes there found.

The Northam Burrows form a large grassy plane, that exists at the level of high water, being perhaps a little below the level of extraordinary spring tides. The burrows are separated from the beach by the extensive pebble ridge, that affords a barrier to the wash of the sea.

The origin of this pebble ridge has not, by geologists, been determined; but I think that the most correct opinion is, that it is formed by the wash of the sea destroying the beds that overlie the pebble bed that exists beneath the clay. This pebble bed we have, by excavations made through the clay, been able to trace to within a short distance of the pebble ridge; recently, borings made for the purpose of obtaining water have shown, that in diminished size these pebbles exist as far up the sides of the shore as the Westward-Ho Hotel. I think, therefore, that there can be little doubt, but that the terrible wash of the Atlantic thins off the clay, and so exposes the pebble bed below to the action of the sea, which, by degrees, carries pebble after pebble to add to the wall that separates the burrow from the beach. That the great pebble ridge is moving inwards, is certain, but the rate of progress has not, I believe, been determined. The gradual movement inwards of the ridge, however fast or slow, exposes all the shore that is seaward of its protection to the destructive agency of the waves; it is to this, and not to any variation in the level of the coast line, that I believe the submergence of the forest along the shore is due. The beach, to a very great extent, is covered by sand, and so protected to a large degree from destruction; but that this has been of only recent occurrence is demonstrable in the quantities of the shells of *Pholas dactylis* that are found in the clay, which must have lived and burrowed their holes after the clay had been exposed to the action of the sea, and before the existence of any sand being deposited on the beach, from the presence of which the beach is still free for a considerable distance above low water mark. The facts, that the beach at the shore extremity is scarcely below the level of the burrows, while the strata of which it is composed gradually thins out as it approximates the low water line, demonstrate clearly, I think, that the submergence of the old forest bed is due to the removal of the beds, and encroachment of the sea, and not to the subsidence of the land. Assuming this to be true, of which I retain no doubt, it follows that the flints found in the clay must have been

deposited since the latest downward movement upon our Devonshire coasts, of which the submerged forests are supposed to afford conclusive evidence.

The next point of enquiry that suggests itself is the connection of the flint flakes found at Northam and Croyde, with those that lie scattered over the Western Promontory. To trace them from spot to spot has not been yet done, but the places at which they have been found throughout Devon and Cornwall are sufficiently numerous to induce one to believe that they may be found everywhere.

Around Barnstaple, in an area of twenty miles diameter, they appear to be abundant. They have been found at Torquay and Brixham; between Ivybridge and Plymouth; abundantly on the moorland around Dosmare Pool; and also at Curza Down, in the Lizard district, &c. In all these localities they lie in the surface soil of the country; and as far as I can see, must have belonged to the same common era. Specimens from the basin on the top of the Maen-rock at Constantine, and those taken from an ancient barrow near Trevose Head, appear to me to afford but small distinction, except that those found in the barrow are less artistic in their form.

In taking into consideration the relation of the flints generally found in Devon and Cornwall, with those existing in barrows, &c., it is desirable that we should give attention to the circumstance under which they were found, and the materials with which they were in connection.

In the barrow, to which reference is made at Constantine, with the flint flakes were found burnt human bones, and a coarse clay vase. In the kitchen-midden found near the barrow, and of which an account was given to this Society at Torquay, pottery of different qualities was found, some of which cannot be distinguished from that found in the barrow; with the pottery procured from the kitchen-midden were found stone hammers, obtained from the rolled pebbles of the sea beach.

Now if we turn our attention to the discovery at Croyde, we find that, both by Mr. Whitly and by Mr. Hall, specimens of coarse pottery have been found, as well as beach stone hammers, that closely approximate in character and appearance with those found in the Constantine barrow and the kitchen-midden. In either case the pottery assimilates in appearance with that of the clay found in the neighbourhood, and is of a quality that approximates it in appearance to that of the present bricks of the county.

It certainly appears to me, that a uniformity of material, with a uniformity of design and application of material, existing under similar geological conditions, is suggestive of an approximation in time; and thus the Croyde, Lizard, and Dosmare pool flints are in all probability of the same age as those existing in barrows containing cremated human bones.

But it must strike the observer as peculiar, that the flint flakes which archæologists pronounce as being the most primitive form of human implement, are found in such abundance in the sub-soil of the Western Promontory, whilst the more perfect flint tools of St. Achin, &c., are found in the drift period of geology; thus placing the more complex and perfected structure at a far earlier geological period than the flint-flake, a fact that is not consistent with the latter being the more primitive form of the two.

Now if we look upon the flakes, as I believe they are, as parts only of a more perfect tool—some being the heads of ancient arrows—which themselves would be useless without the assistance of a stringed bow, an instrument, I think, that required a higher degree of thought to suggest, than did either the hatchet or spear. Now as arrows were in use, and retained as instruments of chase and war until a late period, it is tolerably certain that flint was retained, owing to the scarcity of metal, long after the use of iron was known.

Recently, while pursuing research in an ancient British burial-place, in which the Roman feature of civilization has largely entered, we found, in a grave with a human skeleton, besides two vases, a bronze beaded fibula, some rings, and parts of an armlet, a specimen of a flint core, from which flakes had been struck. Now the presence of this flint core is witness that the material was still in use after the Roman invasion; and therefore I contend, that there is no evidence to show that these flint flakes may not have been coëval with the civilization of the period that immediately precedes the introduction of Roman civilization into this county.

EXPERIMENTS TO DETERMINE THE RATE OF MAGNETIC DEVELOPMENT IN IRON, WHILST UNDER THE ACTION OF ELECTRICAL CURRENTS,

With some practical inferences deducible therefrom.

BY J. N. HEARDER, ELECTRICIAN, PLYMOUTH.

WHEN an electrical current is made to traverse an insulated wire, coiled round a bar of iron, magnetic attraction is produced in the iron, the strength of which depends upon a variety of circumstances, such as the number and position of the coils upon the bar, the resistance of the wire, and the strength of the electrical current.

Strong currents, that is to say, the currents in which the greatest quantity of electricity passes in a given time, produce the greatest amount of magnetism.

It is a valuable desideratum, especially where a great amount of magnetic power is required, to know what relation there is between the quantity of electricity employed and the amount of magnetism developed. As with a badly constructed steam-engine it is possible to expend an immense quantity of fuel with very little effect, so with defective electro-magnetic arrangements the amount of waste is even still greater. The injudicious disposal of the wire upon the bar, the improper adjustment of its resistance to the electromotive force of the battery, or the inadequate size of the magnet, may make enormous differences in the amount of power obtained with the same quantity of electricity.

With a view to discover something of the character of these influences, the author more than twenty years since invented an instrument, to which he gave the name of "magnetometer," which he found capable of determining with accuracy every possible diversity in the influences produced by modifications in any of the elements employed.

Many of the results of his labours were detailed to the Plymouth Institution between the years 1845 and 1848. The Royal Cornwall Polytechnic Institution honoured him with their silver medal for his invention in 1845.

The instrument is described and figured in Dr. Noad's Lectures on Electricity, vol. ii. It may be briefly described as a very delicate but strong steelyard, mounted with counter

balancing weights, and having suspended from the short arm a contrivance for attaching armatures, or keepers, to be employed for testing the amount of attraction developed in the magnets under experiment.

The instrument also contains appliances for bringing various kinds of magnetic arrangements under trial.

The only one which bears upon the immediate subject of this paper will require notice.

This consists of a horse shoe magnet, made of a cylindrical bar 1¼ inch thick, and 28 inches long, bent into the form of a U, having coiled upon its arms a rope consisting of twenty-four strands of copper wire, each 12 feet long; these wires were all insulated so as to be electrically independent of each other, and being twisted into the form of a rope, all bore the same relative position with regard to distance from the surface of the bar.

By means of a set of binding screws these wires could be all connected in various ways, either consecutively by joining end to end, so as to form a single wire of 288 feet in length, or collaterally by joining similar ends together side by side, so as to form a short thick conductor 12 feet long and twenty-four strands in thickness; or they could be joined so as to form conductors of any intermediate lengths and thicknesses.

Or again; the wires, being all nearly of the same conducting character, could be used as so many separate elements, either in conjunction with, or in opposition to, each other, thus constituting a differential magnetometer.

The present paper will be confined to an examination of the relation between the development of magnetic power and the increments of electrical force. The mode of procedure was as follows. Twenty-four separate Smee's voltaic elements were prepared, and their several values in the development of magnetism were separately ascertained by applying each in succession to one of the wires, viz., a single strand 12 feet in length. The amount of attraction was noted, and set down as the value of that individual element. Each element was numbered, and its value attached. In the next place the conducting character of each individual strand of wire was ascertained by employing a single voltaic element, and applying it in succession to each. The difference was so slight that the mean was set down at 14½ lbs., only one or two having varied very slightly above and below this average.

The wires being also numbered, a separate Smee's element was allotted to each, and these, being consecutively excited, formed so many definite and independent integers to be used

as increments of electrical force. It was thus easy to note the increase of attractive power as each additional wire and battery were brought into action. The following table gives the results.

The first column indicates the number of the wire. The second and third columns indicate the numbers of the batteries, with their respective electrical values. The fourth column shows the observed increase of effect due to each battery. The fifth, the total observed effect for each number of elements. The sixth, the calculated sum of the electrical value of the elements employed. The seventh, the discrepancy between the calculated and observed effects, either above or below the sum of the electrical elements employed.

Table shewing the rate of magnetic development in iron by successive increments of dynamic electrical currents.

1 Number of Wires.	2 Number of Batteries.	3 Value of Batteries.	4 Observed Rate of Increase.	5 Increase of Weight by Experiment.	6 Increase by Calculation of the Sum of the Batteries used.	7 Difference between Actual and Calculated Effects.
1	1	14½	14½	14½	14½	
2	2	18¼	28	42½	32¾	+ 9¼
3	3	17¼	28	70½	50	+ 20½
4	4	13½	23½	94	63½	+ 30½
5	5	15¾	17½	111½	79¼	+ 32¼
6	6	15	13½	125	94¼	+ 30¾
7	7	14½	17	142	108¾	+ 33¼
8	8	18¼	13	155	127	+ 28
9	9	17¼	14	169	144¼	+ 24¾
10	10	13½	5	174	157¾	+ 16¼
11	11	15¾	12	186	173½	+ 12½
12	12	15	9	195	188½	+ 6½
13	13	14½	12	207	203	+ 4
14	14	18¼	11	218	221¼	− 3¼
15	15	17¼	11	229	238½	− 9½
16	16	13½	7	236	252	− 16
17	17	15¾	2½	238½	267¾	− 29¼
18	18	15	6	244½	282¾	− 38¼
19	19	14½	7½	252	297¼	− 45¼
20	20	18¼	4½	256½	315½	− 59
21	21	17¼	3½	260	332¾	− 72¾
22	22	13½	4	264	346¼	− 82¼
23	23	15¾	3	267	362	− 95
24	24	15	4	271	377	− 106

From these experiments it will be seen that the rate of magnetic development bears a most irregular and paradoxical relation to the increments of electrical power.

The first three additions gave effects which were nearly double the value of the exciting element; after this, up to nine elements, the rate of increase was nearly commensurate with the value of the elements added.

From this point the rate of increase began to diminish, as compared with the value of the batteries added, until about half the series had been employed, when the observed power was about equal to the sum of the elements. In the second half of the series the ratio of increase rapidly diminished, until at last the increase of effect was only equal to about one fourth of the value of the element added. There appears, then, a point in the process of magnetic development in iron, beyond which there is a sacrifice of economy in the consumption of battery power.

The first half of the series produced an attractive power of 195 lbs., whereas the second half only gave an additional amount of 76 lbs.

Again, the first six elements produced an effect equal to 125 lbs., whilst the addition of the last six only gave an increase of 26½ lbs.

From the foregoing experiments I draw the following conclusions.

1st. That with a magnet such as I employed, namely, a bar of iron, 1¼ inches in diameter, and 28 inches long, bent in the form of a U, the greatest amount of magnetic power in relation to the expenditure of electricity was obtained when only three elements were employed, and that either three or four elements would constitute the most economical subdivision of the whole group of twenty-four. That is to say, to obtain the greatest amount of magnetic attraction from the battery, surface, and the wire circuits, instead of concentrating the action of the whole upon one single magnet, it would be better to employ six magnets, and sub-divide the batteries and wire circuits into six groups of four each, the effect then being as $94 \times 6 = 564$, against 271, or more than double.

The sub-division into eight groups of three each, applied to eight magnets, would produce the same effect, namely, $70\frac{1}{2} \times 8 = 564$; but as two extra magnets would be necessary, the economy would be thus diminished.

It might, perhaps, be a question whether four magnets and four sub-divisions of the batteries and circuits might not be almost as economical; the power being then $125 \times 4 = 500$, or

nearly double the effect produced by a single magnet, the loss of 64 lbs. of power being set against the saving of the two magnets.

One thing is very certain, namely, that it is highly injudicious, and that it involves a great sacrifice of electrical power, which is the great source of expense, to attempt to excite electro-magnets beyond a certain point.

A second conclusion deducible from these experiments is, that the very irregular rate of increase of magnetic attraction in relation to electrical power renders the former totally unfit to be used as a measure of electrical force. All instruments, therefore, professing to indicate the value of electrical currents by the attraction which they excite in electro-magnets, are worse than useless.

When it is wished to employ the magnetometer as a measure of electrical force, it can be done by fixing on any given standard of attractive power, and then comparing the relative arrangements of battery and circuit necessary to produce this degree of attraction.

It would be rather difficult, by any theories at present in vogue, to account for this rather anomalous increase of the rate of magnetic development in soft iron over the amount of electricity employèd, though the decrease in the rate when high powers are employed is quite compatible with all experience in magnetism. In building up steel magnetic batteries, for example, the latter additions to a powerful magnet appear to exert but very little effect.

The case, however, is not without its parallel. The author discovered the same curious fact in relation to building up permanent horse-shoe magnets of cast iron, in which, strangely enough, the united attractive power of twenty-four magnets was nearly twice as much as the sum of their individual values.

The author first detailed this fact to the Royal Cornwall Polytechnic Institution some years since, and the Society, whilst awarding him their silver medal for his invention of the cast iron magnet, were so struck with the singularity of the fact, that the whole was more than equal to the sum of its parts, that they appointed a committee of its most scientific members, including the eminent magnetist, Mr. Robert Were Fox, to examine and report upon the magnet. After an elaborate series of experiments the Committee fully confirmed the facts noticed by the author.

The experiments detailed in this paper must, of course, be taken only in relation to a magnet of the precise dimensions

of the one employed in the investigation, since there can be no doubt that the whole of the series would be materially varied by employing either smaller or larger magnets. In the former case, the excessive progression would terminate sooner, and in the latter case it would most likely be continued through a much greater portion of the series, since mass has evidently much to do with magnetic penetration, and the employment of high degrees of magnetic power would seem to point to a condition which might be termed magnetic saturation.

Dr. Daubeny gave a short communication on the dependence of the amount of ozone upon the direction of the wind.

He pointed out, as the result of observations carried on at Torquay, and continued during seven months in the course of the winters of the last three years, that the average amount of ozone during the prevalence of winds from the north, bore the proportion of less than one quarter to that observed when the direction of the wind was S.W., the average proportion of ozone being, when the wind was S.W., 84.1; W., 82.0; S., 73.0; E., 55.7; N.W., 51.1; N.E., 49.8; S.E., 33.3; N., 20.4. Whether this difference arises from the air blowing over the sea, in cases where the amount of ozone was greatest, must be determined by observations made on the opposite coasts of Great Britain, as well as in Devonshire; but be that as it may, the larger amount of ozone present in air coming from the S.W., W., and S., may tend to explain the greater salubrity of the sea coasts in such situations, when the former winds more commonly prevail.

W. Brendon, Printer, Plymouth.